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GEOGRAPHICAL SURVEY	PSYCHOPHARMACOLOGY	POLAR RESEARCH

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This is a quarterly publication presenting articles covering recent developments in Far Eastern (particularly Japanese) scientific research. It is hoped that these reports (which do not constitute part of the scientific literature) will prove to be of value to scientists by providing items of interest well in advance of the usual scientific publications. The articles are written primarily by members of the staff of ONR → next page

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SYOWA STATION	RHEOLOGY	MAGNETO HYDRO DYNAMICS (MHD)
WORLD WEATHER WATCH	FLUORESCENCE	OPTICAL COMMUNICATION
TYPHOONS	IMPACT STRENGTH	SWIRLING FLOW
ATMOSPHERIC TURBULENCE	MORPHOLOGY	HYDRO ELASTICITY
CEREBRAL DOMINANCE	FLUID MECHANICS	POLYMER CONCRETE
AUDITION	HYDROFOILS	VORTEX RINGS
POLYMER	CAVITATION	

20. ABSTRACT (CONT.)

cont → Tokyo, with certain reports also being contributed by visiting stateside scientists. Occasionally a regional scientist will be invited to submit an article covering his own work, considered to be of special interest.

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THE COVER: A type of calligraphy, an art form highly regarded in Japan and other parts of the Orient. It was drawn by Mrs. Kazuko Ishibashi, an instructor of Japanese at the American Embassy, whose signature appears in the left column. The quote is from Dogen Zenji, 13th century founder of a Zen sect, and the meaning is obscure. It translates into "Eyes horizontal, nose vertical," and was spoken by the Patriarch upon his return from China, bringing to Japan a new religious philosophy.

THE NAVY'S GIFT TO JAPANESE RADIO RESEARCH

Edward T. Pierce

The Chubu Institute of Technology is located in a suburb some twenty miles to the northeast of the City of Nagoya. Nagoya is probably the most thoroughly Japanese of all the large cities in Japan. Tokyo is too big, too international, and too dominated by political and governmental affairs; Osaka is absorbed in large scale commerce, business, and industry; Yokohama and Kobe have the cosmopolitan flavor inseparable from major seaports; Kyoto is for tourists; while, because of their remote locations, Sapporo, in the northern island of Hokkaido, and Fukuoka to the far south in Kyushu, have never been in the mainstream of Japanese life. But Nagoya has always been squarely in the center. The city is located on the ancient Tokaido road almost halfway between the Kanto (Tokyo) and Kansai (Tokyo-Osaka-Kobe) areas. Japanese history is a sequence of dominance either from Kanto or from Kansai, and as power ebbed and flowed along the Tokaido road it always passed through Nagoya. The city conveys a strong sense of history; this is so even in its industries. Inevitably, many of the two million inhabitants work for Mitsubishi or Toyota or some other of the industrial giants of modern Japan. But many workers also create traditional products such as fine china (Noritake), Seto ceramics, silks, fans, cloisonné ware, and pearl articles. It is perhaps symptomatic of the deep affinity of Nagoya with things Japanese that pachinko and pachinko halls were invented in Nagoya. No Westerner can understand the immense and long-continued appeal of pachinko, a mindless pinball game, to the Japanese; it is an aspect of the East that remains inscrutable.

The Chubu Institute is part of the private university system in Japan. About 80% of Japanese university students are enrolled in private schools; only 20% attend national universities such as Tokyo, Kyoto, or Nagoya. The competition to enter the national universities is very fierce since they have many advantages over the private schools. Some of these, drawn from a 1974 survey, are shown below.

	National	Private
School fees	¥36,000	¥151,000
Expenditure per student	¥1,225,000	¥280,000
Class Size	9	31

The best students and instructors naturally gravitate to the national universities; this is true in science as well as in the arts. "Big" (and expensive) science is especially concentrated in the national schools. The private universities deal more in "little" science where ingenuity has more scope in compensating for a lack of resource.

One aspect of the national university system, however, that works to the great advantage of the private schools, is the strict retirement policy of the national system. Most national university professors, whatever their degree of distinction or capacity for future work, retire at 63. The retirement is effectively complete; the retiree rarely remains on campus in an emeritus status as an ever-present potential source of friction with his successor. He usually severs most connections with his past university, and if—as frequently occurs—he remains active and energetic, he will seek other outlets for his talents. A private school is the natural haven. Private schools have no rigid retirement policies; they welcome distinguished elderly scholars, and the welcome is especially warm if the scholars by their reputation can attract students and funds to the private institution. A peculiar consequence is a void in the middle-ages within the faculties of many private schools. The staff often consists of very senior professors and very junior associates. Oddly enough this age-mix operates quite effectively; there is a rapport between the old and the young scientists, comparable with that so familiar between grandparents and grandchildren.

Nagoya University, the Chubu Institute of Technology, and Professor Atsushi Kimpara provide an excellent example of the interplay in Japan between national and private schools. Professor Kimpara is one of the senior statesmen of Japanese radio research. In 1949, Dr. Kimpara, then a professor at Nagoya University, founded the Research Institute of Atmospherics within that university. Originally, this Institute concentrated only on studies of the conventional atmospherics generated by lightning, but under the forceful direction of Professor Kimpara a very considerable expansion of the scientific fields of activity occurred. The work now covers phenomena in fair weather tropospheric and stratospheric electricity and their association with pollution; location of the sources of atmospherics and their meteorological connections; statistics of lightning and radio noise; radio propagation at VLF (3-30 kHz and ELF (<3kHz) including Schumann resonance effects; whistlers and VLF emissions; and solar radio astronomy. The facilities are extensive; besides the main observatory at Toyokawa there are five subordinate observatories in other parts of Japan, while rocket soundings are carried out at the Kagoshima Space Center and at the Showa Antarctic Base.

Professor Kimpara retired from Nagoya University and the Directorship of the Research Institute of Atmospherics in the middle 1960's. He then joined the staff of the Chubu Institute of the Magnetosphere; the title was in tune with the scientific mood of the times. The resources of the Chubu Institute are far less than those of Nagoya University. Thus Professor Kimpara was faced with the problems of creating an experimental program with minimum expenditures—"little" science in fact. It was the United States Navy which, by setting-up the VLF transmitter at N. W. Cape in Australia, provided the first step towards the solution of Professor Kimpara's problems.

The United States and British Navies have long employed VLF (3-30 kHz) radio waves for global communication. The VLF signals have the especial advantages of stability and low attenuation characteristics. Radio scientists, for many years, have monitored the naval VLF transmitters in efforts to understand the characteristics of the transmission medium. Thus, the geographical accident that the British Admiralty transmitter GBR (16.0 kHz) was located at Rugby 100 km from the University of Cambridge led to a classic series of researches. At a distance of 100 km, the ground and first sky waves are readily distinguished and interpretation of the sky wave behavior is most informative on the morphology and disturbances of the lower ionospheric D region. Monitoring of GBR at Cambridge led to several Ph.D. theses and to a survey paper in 1951 by Bracewell, Budden, Ratcliffe, Straker, and Weekes; rarely in the history of radio science has a paper had such a distinguished multiple authorship. More recently, phase and amplitude measurements on long-distance VLF transmissions have become commonplace, and together with observations of natural VLF atmospherics and the development of the wave-guide mode theory by Wait, Galejs, and others, have led to an excellent understanding of the main features of VLF propagation.

On the mode theory the VLF propagation occurs in the wave-guide formed by the earth and the lower ionosphere. Different modes are excited by the transmitter and each mode propagates with different characteristics. The major influences controlling the propagation are ground conductivity (sea, land, perma-frost, ice-cap, etc.); orientation of the propagation path with respect to the geomagnetic field; and especially the conductivity profile and effective height of the D region. These last vary geographically and also with time. The temporal variations may be regular as with the considerable change from day to night or with seasons; they may also be abrupt and unexpected as when solar storms and resulting ionospheric disturbances occur.

Almost all VLF transmitters are located in the Northern Hemisphere of the globe. So also are the technically well-developed countries in Europe, in North America, and in the Far East, where long distance VLF transmissions are normally monitored. It follows that the VLF data is dominantly for E-W or W-E paths, and that, in consequence, the paths usually include a mix of day and night conditions for the upper (ionospheric) wave-guide boundary. Furthermore since most of the land masses are in the Northern Hemisphere, there is also often a mix of land and sea at the lower (earth) boundary. The mixed nature of both boundaries complicates the interpretation of experimental data using the wave-guide mode theory.

Professor Kimpara recognized that the path from the N. W. Cape (NWC) Australian transmitter to Japan lies almost entirely over sea, and closely approximates a S-N direction. Thus the lower earth boundary of the wave guide is uniform (sea) not mixed. Furthermore, because of the S-N orientation the dawn and dust transitions

occur quite rapidly so that the upper ionospheric boundary is also usually uniform being either completely night or completely day. Because of this uniformity for both boundaries and also since the path lies approximately along the geomagnetic field, waveguide interpretations are much simplified.

Continuous phase and amplitude monitoring of VLF transmissions is easily accomplished; appropriate equipment is commercially available. Measurements on NWC (22.3 kHz) were started by Professor Kimpara at the Chubu Institute in 1968, and have continued ever since. Professor Kimpara's lead has been followed by other Japanese establishments, and there is now an immense mass of Japanese data on the phenomenology of the NWC–Japan path. These data have been systematically analysed with the thoroughness and diligence so characteristic of the Japanese scientist. Unfortunately most of the results of the analyses are only available in Japanese; the few papers that have been published in English represent only the tip of the iceberg. Some of the major findings are, however, summarized below:

1. Sunrise is earlier in Japan (Chubu Institute) than at NWC except from 20 November to 19 January; sunset is earlier in Japan than at NWC except from 20 May to 25 July. The fading pattern at sunset or sunrise is closely correlated with the angle between the propagation path and the sunset or sunrise lines, with the pattern being the more pronounced at sunrise.

2. Fading patterns are very sensitive to the chosen ionospheric parameters. From March to October (N. summer) the fading patterns are qualitatively similar. This implies a quite limited variability in ionospheric height and conductivity parameters.

3. During daytime propagation, even over this long path (6774 km.), it is essential to consider both first and second order modes in order to obtain maximum agreement between theory and the experimental data. Propagation cannot, as has been assumed by so many authors, be taken as being by the first mode alone; the second mode must also be included. Pappert and Anyder (1972) at NELC have also stressed the importance of including modes of higher order than the first.

4. When sudden phase anomalies (SPA) occur, due to solar flares, the phase shift in degrees is well correlated with solar noise and X-ray data. Specifically, the phase shift is linearly related to the increased X-ray flux from 2 to 12 Å.

5. Normally an SPA is a positive phase advance (lowering of the ionosphere). However, when the increase in solar X-ray flux during a flare is small, and the solar zenith angle is large (quasi-dawn or quasi-dusk) the SPA is negative. This has been explained theoretically by M. Ohshio.

REFERENCE

R. A. Pappert and S. P. Snyder, "Some results of a mode-conversion program for VLF," Radio Science, 7, 919-923 (1972).

ASPECTS OF POLYMER RESEARCH IN JAPAN

R. K. Eby and E. A. Kearsley

Japan is a world center for polymer research. The authors, who are normally colleagues in the Polymers Division of NBS, were therefore fortunate to arrange a quick trip together to several laboratories in this field. This article is a joint effort at summarizing what they learned. A number of centers for polymer research were visited. In chronological order they are:

Society of Polymer Science; Kureha Chemical Industry Co., Ltd.; Department of Applied Physics, University of Tokyo; Department of Polymer Chemistry, Tokyo Institute of Technology; Department of Polymer Chemistry, Kyoto University; Institute for Chemical Research, Kyoto University; Hirakata Plastics Laboratory, Ube Industries, Ltd.; Department of Polymer Science, Osaka University; and Departments of Applied Chemistry and Applied Science, Kyushu University.

Of course, this is not a complete list of even the principal polymer research centers in Japan, nor, for that matter, is this report an exhaustive account of the ongoing research at these centers or by the researchers interviewed. Since nine visits were compressed into little over a week, discussions were necessarily centered on topics of immediate interest.

The Society of Polymer Science, Japan has its headquarters at 5-12-8 Ginza, Chuo-ku, Tokyo (104). The current President is Junji Furukawa. The Society grew out of the earlier Association of Polymer Chemistry which was founded in 1944 and dissolved to form the new organization in 1951. The Society of Polymer Science is somewhat different from most scientific societies in that it draws its members from many fields such as medicine, machinery, electricity, architecture, agriculture, etc. provided only that they have a strong interest in high polymers. At present, it consists of over 12,000 members and is supported by about 600 companies. The objectives of the Society are concerned with research and development on high polymers. In order to realize these objectives, the Society has a variety of activities. The Annual Meeting, the Symposium on Polymer Science, and summer schools are the most important of them. There are 8 branches and each of them also conducts activities. The Society invites prominent scientists from abroad and provides advice and suggestions for the Government and international organizations. Every year since 1965 it has awarded prizes to those who have carried out the most important and significant studies of the year. An important activity is publication of books and the following periodicals: *Polymer Journal* (bimonthly in English) since 1970; *Kobunshi Ronbunshu* (monthly in Japanese, abstracts, tables and figures in English) since 1944; and *Kobunshi* (monthly in Japanese) since 1952. (It was gratifying to find in *Kobunshi* an advertisement by Shibayama Scientific Instrument Company of Tokyo which sells NBS polymer standard reference materials.)

Polyvinylidene fluoride (PVF_2) can be made piezoelectric by poling and it has recently been much used in the construction of microphones and earphones, especially in Japan. The amount of material used for this purpose is certainly small from the point of view of a large scale chemical manufacturer but one can envision a growing multitude of uses for the property which would greatly increase the amount involved. The Kureha Chemical Industry Co., Ltd. is the only Japanese producer of PVF_2 and it is interesting to compare it to Pennwalt Corporation, the only U.S. producer. Kureha is a medium sized chemical company which was founded in 1944 and now produces plastics, organic chemicals, inorganic chemicals, petrochemicals, fertilizers and agricultural chemicals. Approximately 50% of its sales are in plastics such as polyvinylidene fluoride, polyvinylidene chloride and polyvinyl chloride in sheet, film, fiber, bag, and bottle form. It is the producer of "Grandturf" which carpets Tokyo's Korakuen Stadium as well as of carbon fiber and tiny spheres of activated carbon formed

from pitch. These are being used, by the way, by researchers at the Institute of Medical and Dental Engineering in the development of a new type of artificial kidney (see *ONR Tokyo Scientific Bulletin* Volume 1 Number 2). An interesting activity at Kureha is the extraction of a certain polysaccharide from fungi for use as a drug against cancer. It works as an immunal stimulant to counteract the effects of other anti-cancer drugs. This polysaccharide is taken orally with a molecular weight of about 10,000, but as was pointed out to us, little is known about the subsequent break-up or recombination of the drug in the body. Kureha plans a continuing search for new bioactive chemicals and drugs. It produces various copolymers and polymers for food packaging as well as the PVF_2 mentioned earlier. The biggest use of PVF^2 is for fish nets, because the material matches reasonably well the index of refraction of sea water.

Much of the polymer research is carried out at the Nishiki Research Laboratories which are directed by Dr. Hiramishi Watanabe. At this laboratory, Dr. Naohira Murayama and a group of about six scientists carry out active research on polyvinylidene fluoride which, when prepared in the β form and poled by a strong electric field at elevated temperatures, exhibits the piezo- and pyroelectric properties. Some recent work has been concerned with depolarization measurements which showed five temperature ranges of depolarization. They conclude that only one of these is associated with the mechanism of piezoelectricity since it correlates with the piezoelectric coefficient. Other work shows a fair amount of sample-to-sample variation in the nonuniform distribution of piezoelectric activity across the thickness of the samples. An article published in *Ultrasonics* in January 1976 surveys recent developments and applications of piezoelectric polymers. Work on piezoelectric polyvinylidene fluoride followed naturally for Kureha since it made the polymer, was in the film business, and was also interested in films with high dielectric constant for use in capacitors. No doubt their imaginative approach to research is due to the leadership provided by men such as Executive Vice President Hiroji Itoh, an applied chemistry graduate of Tokyo University and a member of the Board of Directors of the Society of Polymer Science. He impresses one with his broad competence and imagination. The address of the Nishiki Laboratories is Iwakishi, Fukushimaken.

In the Department of Applied Physics of the Faculty of Engineering of the University of Tokyo, Yasaku Wada and others are doing interesting research on polymers. A note to be published in *Reports on Progress in Polymer Physics in Japan* derives expressions for the piezo- and pyroelectric constants of heterogeneous films. One case includes a composite with piezoelectric particles imbedded in a non piezoelectric matrix. Another article to be published in the same journal discusses the dielectric loss of polyethylene below 4.2K. This loss is attributed to the phonon-assisted tunneling of protons on hydroxyl groups and a quantitative analysis is presented. It is assumed that the hydroxyl group is attached to a backbone carbon atom which also has a short branch attached. The work was reviewed in more detail in *ONR Tokyo Scientific Bulletin* Volume 1 Number 2. Other work involves the development of a new instrument which can simultaneously measure the electric polarization, stress and strain in response to an applied stress. The applied waveform corresponds to a geometrical frequency series from about 10^{-2} to 10 Hz. Data are accumulated and analyzed by a minicomputer to yield the complex modulus, dielectric constant, and piezoelectric constant. The address of the University is Bunkyo-ku, Tokyo 113.

In the Department of Polymer Chemistry of the Tokyo Institute of Technology, Professor Toru Kawai and colleagues carry out research on membranes, model enzymes, crystalline polymers, inflexible polymers and the structure of amorphous polymers. Keizo Miyasaka of the Laboratory of Textile Physics has developed a device for rapid small angle X-ray scattering measurements. The receiving slits are oriented tangentially on a rotating disc with successive slits being located at greater radii and hence at greater scattering angles. By stepping through the series of slits, it is possible to record rapidly the scattering pattern over a substantial angular range. This instrument is being applied to investigations of crystalline polymer annealing and melting and to the deformation of hard-elastic fibers. Wide angle X-ray measurements are being applied to the investigation of thermal motions in polyethylene and to the evaluation of size and disorder in polymer crystals.

At the same institution, but in the Department of Mechanical Engineering, is Professor Yukio Tomita. Along with work on magneto hydrodynamics, and a Mach 2 wind tunnel, he is engaged in rheological polymer studies. He works in normal stress measurements, drag reduction of "polyox" solutions and calculations of visco-elastic flows. He showed me an apparatus for studying pulsatile flow with which he hoped to model and understand some problems of blood flow and a sort of Hero's engine with which he measures normal stresses

from jet reaction forces (which he calls "Sakiadis' method"). With a graduate student, Y. Mochimaru, he is using bounding techniques to calculate flows. The Tokyo Institute of Technology is located at Ookayama, Meguro-ku, Tokyo. Professor Ichitaro Uematsu of the Institute is one of the four Vice Presidents of the Society of Polymer Science.

At Kyoto University in the Department of Polymer Chemistry we talked with Professor Yasunori Nishijima who has an extensive program applying fluorescence techniques to polymer research. The basis for this work is best described in a paraphrase of his words. Fluorescence emission is usually characterized by the spectra, lifetime, quantum yield and polarization. While these characteristics are determined primarily by the excited molecule itself, they are also strongly influenced by the local environment. Besides the emission of fluorescence, there are various radiationless processes through which an excited molecule loses its excitation energy. Any environmental effects which influence the rates of such processes change the lifetime of the excited state as well as the quantum efficiency of flourescence. If an excited molecule interacts with another molecule to form an excited complex (an exciplex or excimer), the emission spectra will be altered by the emission from the excited complex. Environmental effects can thus be seen as a change in emission spectra. The polarization characteristics of the fluorescence are determined by the optical anisotropy of the fluorescent molecule and also by the spatial orientation of the excited molecule in the system. The molecular rotation of the excited molecule during the lifetime of excitation depolarizes the fluorescence and the extent of depolarization can thus be a direct measure of the rotational motion of the molecule in the medium. The characteristics of photoluminescence thus provide information on the local environment of the system. By knowing the basis of such environmental effects, the fluorescent molecules can be utilized as molecular probes for studying molecular motions and internal structure.

This application of photoluminescence has been much developed and is conveniently called the "fluorescence method." The technique has been applied to the investigation of motions of polymer molecules in solution, melts and solids. Molecular orientation distributions, short range interactions, conformations and deformation have all been examined this way.

Professor Shigeharu Onogi is well known in the USA—he once spent several years at the University of Massachusetts, has attended several Gordon Conferences and was the co-organizer of a U.S.-Japan Seminar in Polymer Physics held in Kyoto some ten years ago. Professor Onogi discussed with us some work done with E. Kamei on fracture and the properties in extension of narrow molecular weight distributions of linear polystyrenes and their solutions. They demonstrated that the extensional and fracture properties are principally controlled by molecular structure rather than flaws in the material. Extension rate, temperature, molecular weight and solution concentration were varied in these studies. The effect of branching on the extensional properties is a natural next step in this work. It is also an important problem from a technological point of view since commercial grades of polymers such as polybutadiene, polyvinyl acetate and low density polyethylene can be expected to be more-or-less branched and the "processability" of these polymers can be expected to vary with this branching. Consequently, Onogi and Kamei conducted studies on carefully synthesized star-shaped polystyrene. Roughly speaking, they found the maximum end to end length of a star-shaped molecule to be the most important parameter—the radius of gyration is a very difficult quantity to measure. Their data suggest that the maximum relaxation time for a star-shaped molecule is much shorter than that of a linear molecule of the same molecular weight. On the other hand, linear and star-shaped polymers with the same characteristic time behave very similarly.

Dr. Toshiro Masuda of Onogi's laboratory showed us some interesting and very current work with block copolymers of methyl methacylate and styrene. Logarithmic plots of the creep compliance, Je, versus molecular weight seemed to follow the curve for PMMA rather than that of polystyrene, although we were cautioned that at the time only two points of the copolymer curve had been measured. Dr. Masuda is also looking at block copolymers of isoprene and styrene in various solvents for one or the other component. He will do various rheological measurements on these solutions.

In the same Department Professor Hiromichi Kawai and his colleagues including T. Hashimoto are applying rheo-optical and related methods to polymers. A combination of small angle X-ray scattering and dynamic mechanical measurements has been used to characterize block copolymers and blends. The X-ray data have been

fitted to a domain plus transition boundary model. These results lead to the conclusion that the transition boundary layer is not much different for diblock copolymers of isoprene and styrene and the corresponding blends, but that the domain sizes are much larger in the blends. Correlating these with the mechanical results yields the conclusion that it is the ratio of the boundary to the domain dimension that determines certain of the relaxational properties. Six samples with the same ratio of styrene to isoprene were used to demonstrate (in the molecular weight range from about 10^5 to 10^6) that the thickness of the transition region is insensitive to molecular weight. In fact, neither annealing nor changes in casting solvent produced any significant effect on the thickness of the transition region, provided of course, that solvent evaporation proceeded slowly. Apparently, in these conditions the transition region is not determined by kinetic phenomena and is very stable. Still, there is more to the mechanical behavior than the volume fraction of the transition regions and the group plans further studies such as measuring mechanical properties as a function of molecular weight and looking at quenching effects to establish when the kinetics begin to control the transition region.

These workers are also carrying out rheo-optical studies on films of polyethylene crystallized from oriented melts so that the texture is one of row-nucleated "cylindrites" in which the lamellas are highly oriented with their normals parallel to the machine direction. The resulting material with uniaxial symmetry shows no clear yielding in the machine direction but becomes opaque on stretching and recovers its transparency on release. In the transverse direction a clear yielding is observed. Dynamic rheo-optical measurements were made on these materials over a wide range of frequency. The results are interpreted to mean that the α_1 relaxation is associated with reorientation and shearing of the crystallites. The α_2 dispersion is associated with molecular motion within the crystals. This work appears in preprint form in *Polymer Preprints, 17,* 118 (1976).

Professor A. Nakajima of Kyoto University is one of the four Vice Presidents of the Society of Polymer Science. The University address is Kyoto 606.

The Institute for Chemical Research, Kyoto University, was established in 1915 to meet the needs of research programs in pure and applied chemistry. The Institute was first built at Takatsuki near Osaka, and moved in 1968 to the present address at Uji, Kyoto-fu 611. Graduate education was started in 1962. As of September 1974, the Institute had twenty laboratories and one research facility for nuclear science. More than two hundred scientists including some sixty graduate students are engaged in a variety of research. The following laboratories (and heads) carry out most of the research on synthetic polymers: dielectrics (N. Koizumi), fiber chemistry (R. Kitamaru), polymer separation and characterization (H. Inagaki), polymer solution (M. Kurata) and polymer crystal (K. Kobayashi). The present director is Tsunenobu Shigematsu.

In the crystal laboratory, K. Kobayashi has developed a 500 kV electron microscope which he calls HAREM. This instrument possesses an ultimate resolution far better than 20 nm. Lattice images of 10 nm spacing were obtained from vacuum-condensed gold film under vertical central illumination. He has obtained the first electron microscope images with atomic resolution of radiation resistant molecules such as MoS_2 and chlorinated copper phthalocyanine. He cautions, however, that problems associated with radiation damage, image recording and thermal motions seem to make it improbable that such resolution will be obtained for hydrocarbon molecules. He also cautions that near the focus of a microscope at its resolution limit, "seeing is not always believing" and that therefore the worker must avoid succumbing to "believing is seeing." Further research carried out with his colleague K. Katayama and others is concerned with the crystallization of polymer melts under shear. In a novel apparatus, a polymer specimen 50 to 100 μm thick is sandwiched between beryllium plates to μm thick. One plate is fixed and the other can be sheared. Temperature is changed with an air gun. An X-ray beam is directed normal to the plates and after scattering impinges on a fluorescent screen. The resulting image is recorded with an image orthicon and a video tape recorder. For light scattering, a laser, glass plates and photographic film are used. This apparatus has been used to investigate polyethylene, polybutene-1 and polyethylene oxide. For polyethylene, the amorphous halo disappears before the appearance of the crystal diffraction. When the diffraction does appear, it first shows *c* axis orientation parallel to the shear and later *a* axis orientation. While the X-ray pattern still shows amorphous scattering, the H_v light scattering begins an equatorial streak which suggests a body elongated in the direction of shear. These investigations are being continued and will no doubt shed considerable light on the organization process that occurs as the polymer goes from melt to crystal. In April of 1977, Professor Kobayashi's scientific career will come to a putative end with his formal retirement. This fine scientist will undoubtedly continue to serve our field, however, in an emeritus role.

The rheological work of Professor Kunihiro Osaki, which is done in the Polymer Solution Laboratory of Professor M. Kurata, has already been reported in *ONR Tokyo Scientific Bulletin* Volume 1 No. 2. Professor Hiroshi Inagaki has done considerable work on light scattering from dilute solutions of block copolymers. He has also made molecular weight determinations of ultrahigh molecular weight polystyrene and has used thin layer chromatography with styrene-butadiene copolymers. He reports that he can separate triblock from diblock copolymers in this way. T. Kotaka, Inagaki's colleague in this work, has recently gone to Osaka and we subsequently met him there.

Ube Industries, Ltd. is a company producing coal, cement, machinery and petrochemicals. We visited their Hirakata Plastics Laboratory and talked with Dr. Toshio Nagasawa. Dr. Nagasawa who is a graduate of Kyoto University, spent two years at NBS in 1969-71. He is a clever scientist who also has a knack for applying good science to some very practical problems. He discussed his studies of impact strength of molded plastics. A weighted plunger was dropped against a molded plastic plaque backed by a steel plate with a plunger-matching socket. Data were taken and treated statistically to show that the percent of broken plaques varied linearly with height of fall of the plunger and hence the energy of impact. The energy for which 50% of the samples broke was defined as the impact strength. Plaques made by injection molding are known to form with thin layers of fine crystallites at the mold faces, while plates formed between hot plates are quite homogeneously filled with large spherulitic structures. Thus, the ratios of impact strengths for hot plate formed plaques to injection molded plaques for polyoxymethylene, polypropylene and nylon 6 were 10, 5 and 2 respectively. Amorphous polystyrene showed no effect, which is not surprising, but polyethylene showed an impact strength ratio of 0.8, which is: To examine whether these results were consistent with the idea that the impact strength test is a measure of crack initiation and propagation processes, Nagasawa molded plaques between one cold and one hot plate. The resulting sample showed the fine crystalline layer on the cold side only and had about half the impact strength ratio of the fully hot-plate formed plaques. But, surprisingly, this result was independent of which side of the plaque was impacted in the test. These studies suggest new methods of injection molding to produce improved impact strength.

Other interesting work dealt with nylon fish line used in making nets for Japan's important fishing industry. The line was run through formic acid vapor at 80°C for a few seconds. This solvent dissolved an extremely thin layer of the line and in that layer disoriented the anisotropy induced by a previous drawing of the line. As a result, a slight decrease of one or two percent in tensile strength was observed. But, when a knot was introduced into the line (which reduces the tensile strength) a 50% increase in knot strength was observed. Dr. Nagasawa plans to pursue further these important studies of surface effects.

Other scientists we met at the Hirakata Plastics Laboratory include Drs. Sadao Hoshino and Eiichi Kamei who showed us a large fractionation column which had produced the sample fractions used by Onogi's laboratory in Kyoto. We were also shown a stress-relaxation apparatus being constructed to study relaxation of polymers in different gaseous or vapor atmospheres. This laboratory impressed us with its enthusiastic and productive group of polymer scientists applying a high level of science to industrial problems.

Osaka University has had a long history beginning more than a century ago and including a period as one of the old imperial Universities. Today it has ten Faculties including the Faculty of Science which was established in 1931. This Faculty has five Departments, 41 chairs, 37 professors, 30 associate professors and 21 assistant professors. The Department of Polymer Science has chairs in polymer synthesis, chemical structure of polymers, structural chemistry of solid high polymers, physical chemistry of polymer solutions and polymer physics. This Department is in Toyonaka, Osaka, 560.

In the laboratory of Hiroyuki Tadakoro and his colleagues, Yozo Chatani, Masamichi Kobayashi and others, there is an active and productive program concerned primarily with the structures, spectra and energetics of crystalline polymers. A note to be published in *Macromolecules* proposes the presence of kink bands in modification II (α) of polyvinylidene fluoride. These are offered as an explanation of streaks found between spots of the same h and same k on fiber diagrams. The kinks are associated with parts of a chain changing from .... $TG\bar{T}\bar{G}$-$TG\bar{T}\bar{G}$ .... to .... $TG\bar{T}GTTTTTG\bar{T}\bar{G}$ .... Earlier work on polyvinylidene fluoride reported the measurement and analysis of the infrared and Raman spectra of three crystal forms. Other recent work has been concerned with the polarized Raman spectra of single-crystal n-$C_{36}H_{74}$, potential energy calculations of the stable packings

of polyethylene, theoretical elastic moduli and conformation of single chains in a crystal lattice, and the structure of aromatic polyethers. Dr. T. Kotaka has just come to Osaka from the Institute for Chemical Research in Uji where he was a colleague of H. Inagaki. He plans to do mechanical and dielectric studies of block copolymers in bulk. He has yet to assemble his equipment.

There is a vigorous research program of polymer research in the Faculty of Engineering of Kyushu University. An introduction to this effort is given by Motowo Takayanagi of the Department of Applied Chemistry. "The Faculty of Engineering was started in 1911. Graduate study was initiated in 1953 as a continuation of the undergraduate course, and in 1975 it evolved into a separate unit established by law. The Faculty of Engineering consists of 20 departments. Each Department of a national university having a doctoral program is generally composed of six Chairs, with each Chair comprising one professor, one associate professor, and two assistants, together with some technicians and optional researchers. The budget from the Government is assigned to the Chair as a unit and not to the individual faculty member. The researchers in a given Chair tend to form an intimate research group with common research projects, sharing the common budget. Interdepartmental interaction is generated among Chairs if the research subjects are attractive. Each Chair has its own research area."

At present in the Faculty of Engineering, there are a number of groups concerned with polymers. T. Takemura in the Department of Applied Science was formerly a theoretician concerned with viscoelastic properties but for about fifteen years has been an experimentalist working on dilatometry, DTA, DSC, X-ray and NMR measurements under high pressure. He is developing a high-pressure Raman apparatus. T. Tanaka in the Department of Applied Chemistry is concerned with correlations of the chemical structure of polymers such as ionomers with bulk properties. M. Higuchi in the Institute of Applied Mechanics prior to his recent retirement had been concerned with the establishment of fatigue life criteria for plastics. The work of K. Funatsu in the Department of Chemical Engineering is concerned with the rheology of polymers as is that of N. Mitsuishi in the Department of Nuclear Engineering. Prof. T. Oyama's work in the Department of Applied Science has been with molecular conformations especially those of folds on crystal surfaces. Recent work to be published in *Polymer Journal* is concerned with surface halogenation of polyethylene single crystals. The results of infrared and DSC measurements on such crystals are interpreted in terms of two types of long but regular and interconvertible fold structures. Professor Motowo Takayanagi's active group has long been concerned with the structural interpretations of the physical properties of solid polymers. Recent work of interest has been concerned with the deformation of poly γ-methyl d glutamate. Piezoelectric properties were also measured for oriented film in the α form and found to correspond well with the mechanical relaxation of the same sample. The Faculty of Engineering is in Fukuoka 812.

THE GEOGRAPHICAL SURVEY INSTITUTE: THE MAPPING OF JAPAN

H. J. Walker

INTRODUCTION

Japan, a nation with less than 4 percent the area of the United States and with virtually no domestic energy resources of its own, has become the third major industrial nation in the world; only the U.S. and U.S.S.R. surpass it. Such an achievement, especially when considering the short span of time involved, is highly remarkable. Several factors have been involved: energetic business leaders, efficient organizers, governmental cooperation, willing students, ingenious technology, and dedicated labor, among them. Their output extends from miniaturized electronic equipment to mammoth oiltankers, from delicately cultured pearls to elaborate shore defense systems, and from the establishment of disaster research institutes to the production of highly sophisticated maps. To surveying and map making—which this report addresses—the Japanese have brought their abilities at working with detail, their desire for excellence, and their artistic talents; the result: modern-day maps that are among the most detailed and accurate in the world.

HISTORY OF MAP MAKING IN JAPAN

Although an official map series covering all of Japan was compiled in 1821, it is generally considered that modern systematic mapping did not begin until 1869, i.e., shortly after the Meiji Restoration, when a Survey Division in the Ministry of Civil Services was established. During the 1870's and 1880's several other survey and mapping groups came into existence, the most important of which was a unit within the Intelligence Agency of the Japanese Army. It carried out the initial work in the establishment of the triangulation network of Japan.

In 1884, after some 15 years of random activity, a number of mergers, and a variety of designations, most mapping agencies were combined into one organization, the Survey Bureau of the Army, an organization that 4 years later became the Army Land Survey. This Survey was operative until the end of World War II and during the nearly 60 years of its existence was responsible for the survey and mapping of Japan. The first basic topographical map of Japan was at a scale of 1:20,000. However, because of expense and military exigencies, the Survey decided in 1890 to adopt 1:50,000 as its primary working scale for topographic mapping. Nontheless, it was not until 1925 that the mapping at this scale of the entire country was completed. These maps, compiled primarily for the use of the military, contain conventional signs that were designed along military lines. In addition, those maps which had larger scales than the 1:50,000 used for general coverage were mostly of areas of strategic importance.

Such a situation prevailed until World War II, after which the Army Land Survey was transferred to the Ministry of Construction and renamed the Geographical Survey Institute (GSI).

THE GEOGRAPHICAL SURVEY INSTITUTE: ORGANIZATION

The Geographical Survey Institute, now in operation for over 30 years, is the central surveying and mapping organization in Japan. At the beginning of 1976 it had a complement of 941 (Table 1) and a budget of over 5 billion yen (17.5 million dollars). Its increasing importance in the eyes of the government of Japan is reflected in recent budget increases. Five years ago (1971) its total budget was 2.8 billion yen. The largest increase occurred in 1975 when the budget that year was 1.1 billion yen higher than the 1974 level.

TABLE I

DEPARTMENTS AND PERSONNEL: 1-1-76

	Number
Director	1
Councillor	1
Inspector	2
Departments	
Administration	182
Planning	30
Geodetic	93
Topographic	116
Geographic	118
Map Management	127
Crustal Dynamics	25
Regional Survey	234
Geodetic Observations	12
Total	941

GSI is organized around 8 departments (Table 1, Fig. 1), most of which are located in the Institutes building complex in Tokyo at 24-13 : 3-chome, Higashiyama, Meguro-ku. The major exceptions are the 10 units of the Regional Survey Department. They are scattered around Japan, ranging in location from Sapporo, Hokkaido in the north to Naha, Okinawa in the south.

GEODETIC WORK

The Geodetic Department with nearly 100 employees is responsible for making ground control, astronomical, gravity (land and water), geomagnetic (land and water), ground subsidence, and tidal surveys in Japan. It is also responsible for Japanese surveying in Antarctica.

Since 1973, the Department has been engaged in the establishment of a new geodetic network for Japan. By using high precision electro-optical distance meters it plans on revision of the 6000 first and second order triangulation stations every 5 years and the 32,700 third order stations every 10 years. The stations are already among the most precisely located in the world and together create one of the tightest networks to be found anywhere.

This continuous revision of the location of benchmarks is accompanied by a continuous updating of their levels (Fig. 2A). Leveling precision in Japan is of greater critical need than in most countries because of the great instability of the land as reflected in severe earthquake activity and widespread subsidence.

Sea level changes are also monitored by the Geodetic Department. A Coastal Movement Data Center was established in GSI in 1965 for the purpose of gathering and disseminating the monthly tidal records which are collected through Japan by a number of organizations. This is but one example of the increasing role of the GSI as a collective and disseminating center of data related to its overall activities.

Through its Geodetic Department, GSI is participating in the International Geodynamics Project, a project organized by the International Council of Scientific Unions in 1970. Japan's participation includes research on the Western Pacific Ocean Bottom, mantle convection, and island arc characteristics. It has undertaken similar geophysical studies, as for example, a study to determine the structure and origin of several island groups within its political boundaries.

The GSI activity probably recognized as potentially the most important by the public is the Crustal Dynamics Department, the unit concerned with earthquake prediction. The main activity of this Department is the collection and analysis of various types of survey data; data collected by other organizations in Japan as well as GSI. These survey data include those mentioned above in connection with benchmark leveling, sea level changes, tidal records, gravity surveys, and geomagnetic surveys. In addition, 8 areas have been established for special observation and one (the area around Tokyo) for intensive observation (Fig. 2B). Even though only recently established, the Crustal Dynamics Department has become the coordinating agency for earthquake prediction in Japan. Its Director told me that his Department, being so new, was understaffed and that as elsewhere it was difficult to increase members because of financial constraints.

GEOGRAPHIC WORK

The Geographic Department of GSI has responsibilities equally as diverse as those of the Geodetic Department. For example, it is engaged in map compilation and revision, land use and land condition surveys, water use surveys, disaster surveys, ocean development surveys, and in gathering of data for the National Atlas.

The production of land use maps began in 1952 and to date nearly two-thirds of the country has been covered at a scale of 1:50,000 with the exception of Hokkaido where the scale is 1:200,000. These maps are very useful in a densely populated country like Japan. With the heavy pressure placed on virtually every spot of relatively level land (only 1/5 of the total of an already small area), any change in use must be judiciously considered. The earliest land use maps were prepared for the less developed areas (i.e., those areas where farming and forestry were practised). More recently, however, land use surveys have concentrated on large cities and their environs primarily because of industrial expansion and suburbanization. Because of the greater detail needed in these more recent developments many of the land survey maps have been produced at a scale of 1:25,000 since 1973.

Land condition maps are land classification maps based on landforms and other physical features (Fig. 3B). These maps have a two-fold purpose: first, they are of value in the establishment of procedures for prevention of disasters; second, when used along with the land use maps, they provide a major element in efficient regional land development.

Disaster surveys are one of the most important assignments of the Geographic Department. Land changes caused by floods, earthquakes, landslides, avalanches, and subsidence are routinely surveyed in order to determine the relation between change and cause. Although the 5 disasters mentioned above are those most likely to come to mind first, others also mapped are snowfall, heavy rain, and pollution. The usefulness of such surveys and the maps that result has been demonstrated many times over the years.

An example of how such disaster surveys have led to land condition maps can be illustrated by the survey that resulted in the development of the 1:25,000 flood prevention map series; a series that now covers all of the main flood areas in Japan. In 1959 a large typhoon caused severe flooding in the Isewan area of Japan. Subsequent surveys by GSI showed that there was a close relationship between flooding and landform and led GSI to develop a flood-landform classification. Using this classification, GSI issued its first flood maps in 1960 (the year following its study). Originally the maps were in pairs—one, a flood landform map, the other, an elevation and flood prevention map. In 1964, these maps, after merging them into one, were renamed "land condition maps."

One of the most recent endeavors of the Geographic Department has been concerned with the subaqueous portions of coastal areas. The maps resulting from these surveys are being produced at several scales and include a variety of detailed information (Figs. 3A and 4). Their objective is manifold. With the growing importance of nearshore waters in the livelihood of Japan, these maps are already proving valuable as a source of information in planning.

The Geographic Department is also responsible for the production of maps of the large lakes (mostly at a 1:10,000 scale) and of the major river basins of Japan. Most of these maps are a part of the water use series many of which have been compiled in cooperation with the National Land Agency.

MAPS AND AERIAL PHOTOGRAPHY

Although most of the activities listed above lead to the production of maps of various types, there are more general maps that regularly issue from GSI. These range from very large scale (1:2,500) maps to very small scale (1:3,000,000) maps and are designed for a variety of purposes.

Most maps are now made from aerial photographs. Japan has established regular routines for photographing Japan. The standard photographic scale of 1:20,000 is used in the compilation of maps at 1:2,500 and 1:5,000 scales. Maps of this scale are restricted mainly to the areas where land development projects are planned. Because of rapid land-use changes that take place in urban areas they are rephotographed every 3 years; the rest of the country every 5 years. Much of this mapping is done by private companies under the supervision of GSI.

Aerial photographs at a scale of 1:40,000 are taken for use in the construction of the 1:25,000 national topographic maps which are considered the basic maps of Japan. The production of these maps is possibly the main cartographic task of GSI. Before 1964, the base map of Japan was at the 1:50,000 scale produced before World War II. During the past 10 years however there has been a conversion to the 1:25,000 scale and presently nearly all of Japan is so mapped. These maps are updated at intervals of 3, 5, and 10 years depending on the rapidity of change in the mapped area.

The use of color aerial photography was initiated in 1974. When the flown scales of 1:8,000 and 1:15,000 are combined with the advantages of color, these photographs are making possible an increased accuracy in Japanese topographic maps.

Medium and small scale maps are also issued by GSI. In the main they are compiled from large scale maps. The 1:200,000 (130 sheets) and 1:500,000 (8 sheets) sets are completed; indeed, some are presently in a third revision.

THE NATIONAL ATLAS OF JAPAN

In 1971, GSI began compilation of the National Atlas of Japan. It will be comparable to the one issued a few years back of the United States. The Japanese version will consist of 180 sheets which will be representative of Japan's economic, social, and cultural aspects. A committee of over 50 experts (about evenly divided between academics and governmental specialists) has been involved with the Atlas from its inception. Arranged so that it will portray the regional characteristics of Japan, it contains 13 parts: 1. General Maps, 2. Physical Features, 3. National Development and Conservation, 4. Population, 5. Agriculture, Forestry and Fisheries, 6. Mining, Manufacturing and Construction, 7. Transport and Communications, 8. Foreign Trade and Flow of Goods, 9. Commerce and Banking, 10. Politics and Finance, 11. Social Conditions, 12. Education, Culture and Public Welfare, and 13. Regional Maps.

Thematic maps are being produced at scales of 1:2,500,000, 1:4,000,000, and 1:8,000,000; regional maps, at a 1:1,000,000 scale and city maps at 1:100,000. The Atlas will be 42 x 59.4 cm in size, consist of 400 pages, and be produced in 12 colors. An English edition is being produced which will be available for 80,000 yen from the Japan Map Center, c/o Kudan Ponpian Building, 8-8 Kudanminami 4-chome Chiyoda-ku, Tokyo, Japan 102 as of March 1977. A brochure about the Atlas has been issued by GSI.

THE GEOGRAPHICAL SURVEY INSTITUTE: ADDITIONAL ACTIVITIES

GSI, as noted above, is the central surveying and mapping organization in Japan. However, it is by no means the only group so involved. In fact, there are over 5,000 private survey companies and map reproduction agencies throughout the country (Fig. 5). These agencies receive technical assistance and guidance in their own operations as well as doing occasional contract work for GSI. GSI is also responsible for conducting the national surveyor and assistant surveyor examinations held yearly in Japan.

Technical personnel are trained at the Construction Technical Training School operated by GSI. There are two regular courses, each one year in duration. The first year is designed for new employees; the second for advanced employees. There are also occasional short courses held for training in new and advanced techniques.

Although most of GSI's activities are focused on Japan, there is work conducted under two different foreign formats. First, GSI is a major participant in the Japanese Antarctic Program some aspects of which were described above. Second, it is deeply involved in furnishing technical assistance to developing countries. It also has educational programs for the training of foreign surveyors and cartographers. To date, foreigners from more than 20 countries have studied in their training programs.

CONCLUSIONS

Although GSI has a very efficient operation it is extremely crowded in its Tokyo quarters. Despite cramped quarters (which some sociologists might prefer, because of), the output has been of high volume and high quality. In addition, as best I could determine during a short visit to the Institute, scheduling is realistic and schedule-maintenance is commonly achieved. The major difficulty with such facilities is the limited possibility of adding new equipment (some of which is being developed by GSI itself) as it becomes available.

The difficulties inherent in cramped, outmoded quarters will soon be relieved. There is presently under completion a GSI complex in "Tsukuba Academic New Town" as the Japanese call it. A 19 hectare area has been set aside within 2 km of the University of Tsukuba, itself presently under completion (see the comments about this new development by M. A. Bertin on pp. 55-56 of Vol. 1, No. 1 of this series). The main building is now complete and GSI is scheduled to make its move from the Tokyo site to Tsukuba 60 km to the north in 1978.

The Japanese are generally anxious for foreigners to see the quality of and detail in their work; cartographers are no exception. They are justly proud of their maps and most, if not all, of those produced by GSI are available to the public. The Japanese public itself is fond of maps. Thus it is not surprising to find a wide variety (nearly all in Japanese, however) at train stations and bookstores both of which are numerous throughout Japan.

As a postscript, it should be added that most of the material and diagrams in this report are from a 28-page bulletin published in English by GSI in 1976 entitled "Geographical Survey Institute."

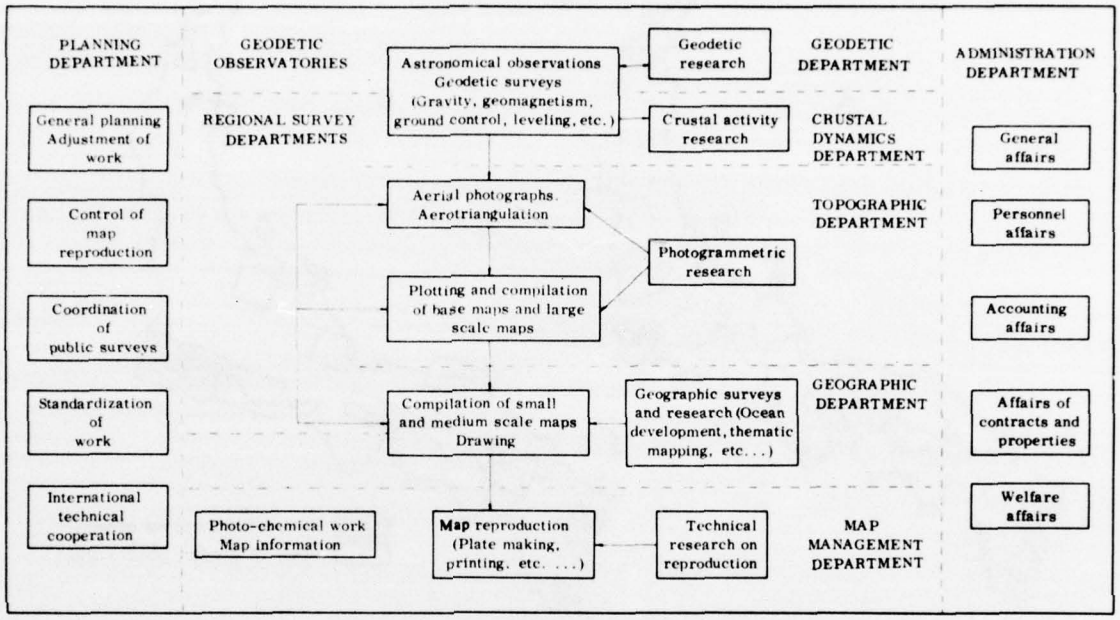

Figure 1. Organization and work flow of the Geographical Survey Institute.

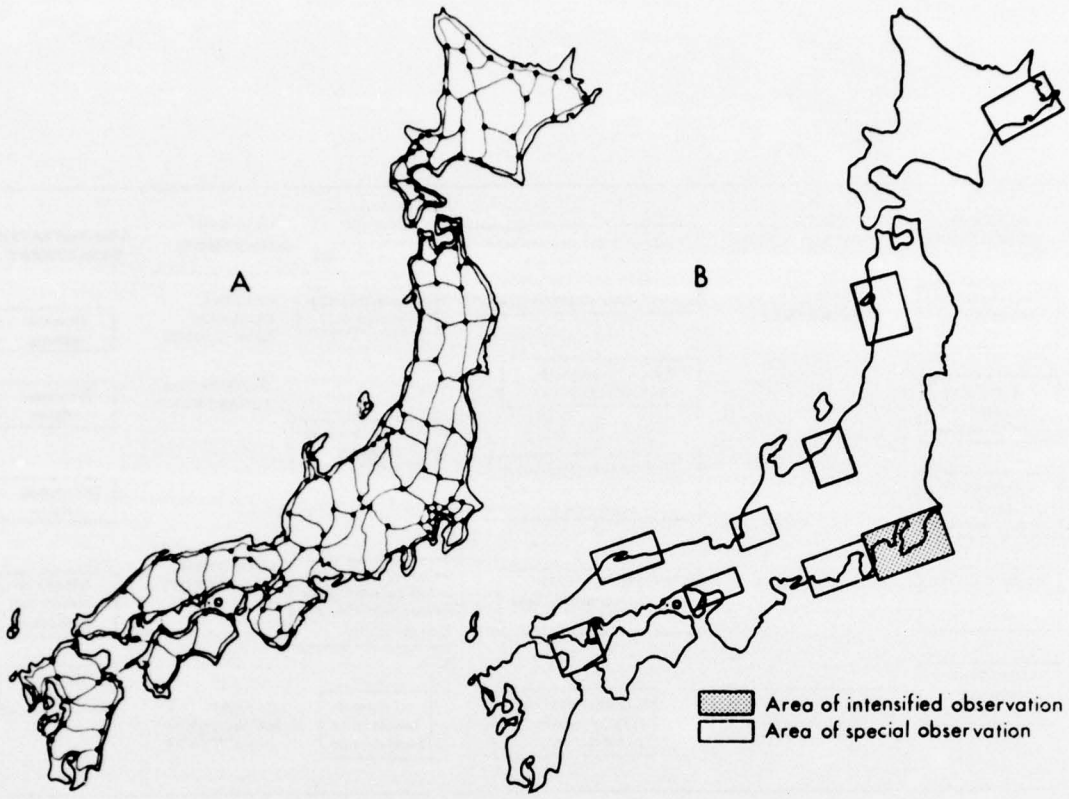

Figure 2. Japan. A. First order leveling stations and routes. B. Observation areas for earthquake prediction.

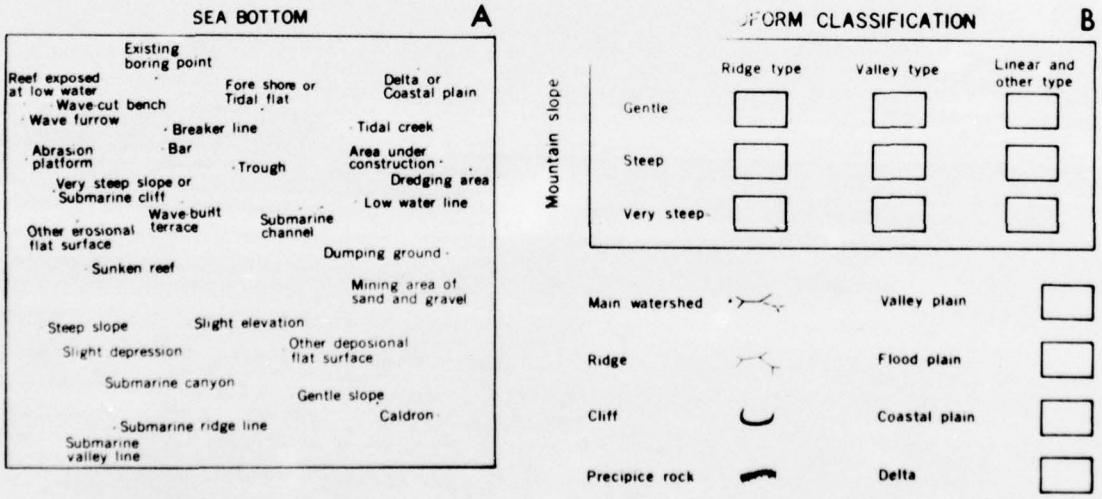

Figure 3. Portions of map legends illustrating detail used. A. Land condition map of coastal area. B. Land condition map.

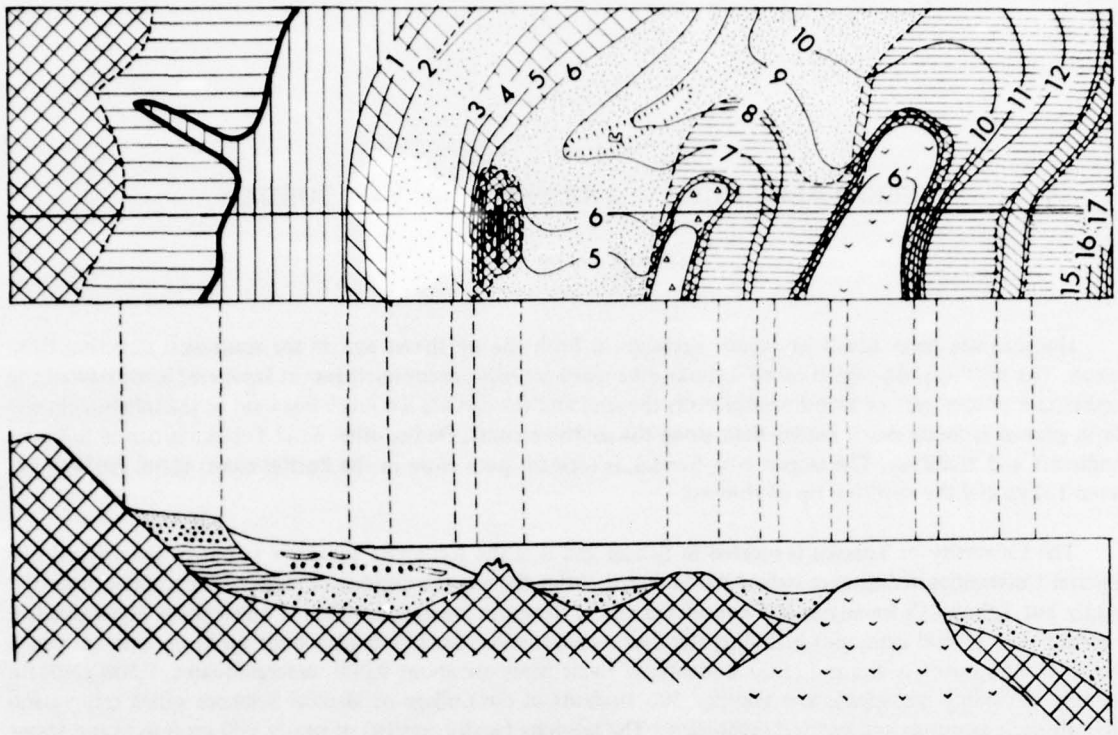

Figure 4. Land classification model of sea bottom.

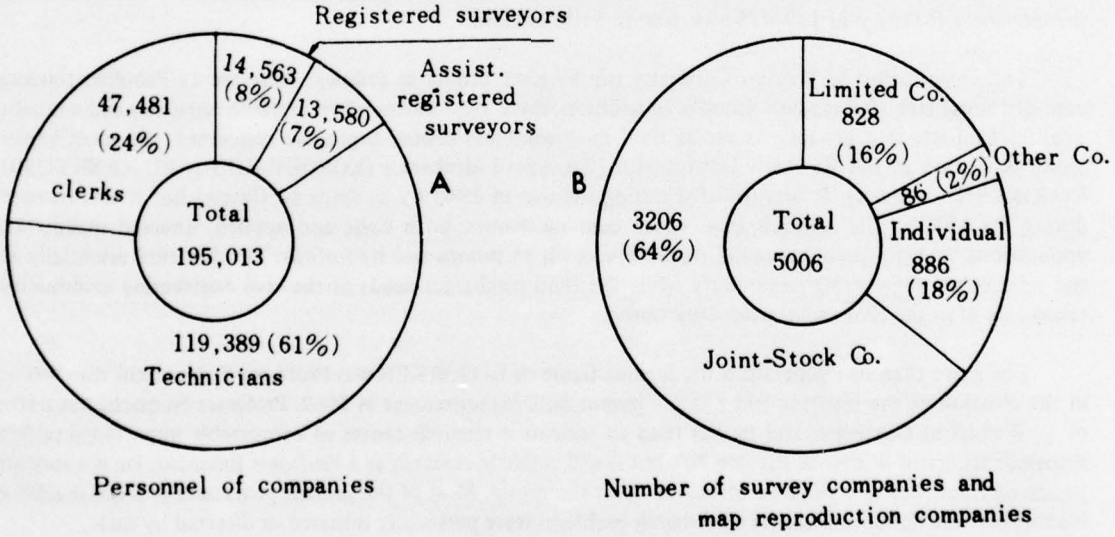

Figure 5.A. Private company personnel B. Private survey and map reproduction companies in Japan.

FLUID MECHANICS AT THE UNIVERSITY OF TOHOKU

Leslie S. G. Kovasznay

Honshu, the main island of Japan, stretches in both the northeast and in the southwest direction from Tokyo. The northeastern region called Tohoku (the word actually means northeast in Japanese) is considered the harsher and poorer part of Honshu since both the land and the climate are much less kind to the inhabitants and life in general is much much harder than along the southern coast. On the other hand Tohoku is rich in folklore, handicraft and tradition. The largest city, Sendai, is located quite close to the Pacific coast, about halfway between Tokyo and the northern tip of Honshu.

The University of Tohoku is located in Sendai and it is the legitimate successor to one of the original five Imperial Universities in existence before World War II. After the war the number of national universities increased rapidly but Tohoku University is still considered one of the more prestigious national universities. The university is spread over several campuses including the new Aobayama-Kawauchi complex built up in the last ten years. The total enrollment is about 12,000 students; of those there are about 9,000 undergraduates, 1,500 graduate students (including medicine), and another 500 students in the College of Medical Sciences which trains paramedicals such as nurses and medical technicians. The teaching faculty consists of nearly 600 professors and about the same number of associate professors. If one counts only those two faculty ranks the student-teacher ratio is about 10:1, quite a favorable figure. The total teaching staff is about twice as large (nearly 2,400) and it includes a small number of lecturers and large numbers of assistants. These latter correspond roughly to graduate student assistants in the United States except for the fact that in Japan their position is more secure. The total budget of the university for the year 1974/75 was close to $100 million.

The organization of Tohoku University can be given briefly as follows: there are 11 Faculties (undergraduate divisions) and 10 Graduate Schools. In addition, there are 8 independent research institutes and a number of smaller, semi-attached groups. As far as fluid mechanics and related topics are concerned. the most important group is located in the Research Institute for High Speed Mechanics (KOSOKU-RIKIGAKU-KENKYUSHO or KOSOKKEN for short). It was founded during the war in 1943 by an Imperial Charter but it was reorganized during the 1950's. The research areas cover fluid mechanics, both basic and applied, directed mainly toward applications to high-speed hydraulic machinery, such as pumps and hydrofoils. The Institute essentially serves the mechanical engineering community while the fluid mechanics needs of the civil engineering community are taken care of in the civil engineering department.

For more than one generation the leading figure of KOSOKKEN was Professor F. Numachi who was active in the creation of the institute and was its director until his retirement in 1962. Professor Numachi was a student of L. Prandtl in Göttingen and he has tried to recreate a research center of comparable importance in Sendai. Professor Numachi is now in his late 70's but is still active in research as a Professor Emeritus. He is a very strong personality and exerts a palpable influence upon the group. Most of the present professors of KOSOKKEN were his students and about one-half of all research problems were personally initiated or directed by him.

The present Director of the Institute is Professor H. Murai, presiding over a staff totaling almost 100 people. The academic staff consists of 12 full professors and 8 associate professors supplemented by a comparable number of lower ranks. Professor Murai's personal research interests are centered around high-speed water pumps. He showed me two major facilities: one is a single stage axial pump test stand where full scale pump rotors with supercavitating blades can be tested. The other facility is a cavitation water tunnel. In the cavitation tunnel fundamental studies are being carried out on the influence of up-stream turbulence on cavitation.

The turbulence is produced by a grid, and by changing the configuration both the intensity and the characteristic length scale of the upstream turbulence can be varied, while the cavitation pattern is being studied by using flow visualization techniques.

In order to measure turbulence in high speed water flow, the group has perfected the measuring technique based on using a very small total head tube followed by a small pressure transducer. In a typical configuration the total head tube has an outside diameter of 0.8 and a free length of 3.8 mm protruding ahead of a cylindrical body that houses the pressure transducer (a semi-conductor type pressure transducer with a diameter of 3 mm placed in a cylinder of 8 mm diameter). According to the linear theory, the principal contribution to the observed pressure fluctuation is due to the streamwise component of the turbulent velocity fluctuation. Nevertheless, the static pressure fluctuations are also sensed and these may be due to sound generated elsewhere in the fluid. In some experiments an additional static pressure probe is placed nearby (e.g. on the opposite wall) in order to subtract (at least the low frequency contribution) the static pressure fluctations originating either in the wall boundary layer or in the pump impeller that drives the tunnel. After having used the above described technique to "clean" the signal, further signal analysis is performed. There may be the determination of either the autocorrelation or the power spectrum, or alternately the measurement of the probability density. Details are available in Murai, H. and Ihara, A. "Measurement of Turbulence in High Speed Flow of Liquid," 75-AM JSME B-11, a paper presented at the JSME-ASME joint meeting in Honolulu, Hawaii March 24-27, 1975.

Professor Emeritus F. Numachi still supervises the research work in two major facilities. One is a cavitation tunnel for a single hydrofoil and the other is a cavitation tunnel for a cascade of hydrofoils. It should be mentioned here that about 1/3 of all publications that originated at the institute are related to cavitation in one way or another.

Professor H. Ito is performing high precision measurements on hydraulic components, such as curved pipes, bends, 90° pipe junctions as well as metering orifices. His newly designed metering nozzle was recently adopted by JSME and in addition he has received a prize from ASME for his pioneering work in this area. The new nozzle designed by Dr. Ito has an elliptical contour while the previous ones were made up from two segments of circular arc. The behavior of discharge coefficient of the metering orifice as a function of the Reynolds number is both smoother and much more predictable.

Heat transfer in two-phase flow is the subject of the research of associate professor T. Aihara. Here the two phases are air and glass beads. The smallest beads used are of a diameter of 40 microns and they are rather uniform. Having no smaller beads in the flow one can use 30 micron diameter pressure holes without any danger of clogging. Presently the concentration of the beads represents about equal mass in the two phases but Professor Aihara hopes to increase the ratio by a significant amount. Naturally there are peculiar problems for this type of two phase flow, e.g., the high-speed motion of the beads has a polishing effect on the solid surfaces, the pipe inner surface becomes highly polished and the total head tubes also suffer some erosion. The heat transfer is of course greatly affected by the presence of the solid phase. The principal flow configuration is a straight cylindrical pipe with fully developed turbulent flow. Since the flow velocity is rather high ($\approx$ 40 m/sec) the gravity effects are minor even in a horizontal pipe.

There is a smaller but continuing effort in magnetohydrodynamics (MHD) research under Professor S. Kamiyama in an electrically conducting fluid (both mercury and potassium chloride solution in water are used as working fluid). The experiments were shown to me by Mr. K. Koike and he explained one of the configurations explored. This is the flow between two parallel disks where one is stationary and the other one is rotating. The stationary disk has a hole in the center and the flow is forced into the gap between the two disks. The behavior of such a flow under the imposed axial magnetic field is being studied over a range of parameters. Professor Kamiyama has presented a calculation dealing with such a configuration at the JSME-ASLE International Lubrication Conference in Tokyo in June 1975 under the title of "Inertia Effects of Lubricating Flow in the MHD Hydrostatic Thrust Bearing." Later Mr. K. Koike showed me another configuration. It consists of an oscillating plunger placed into a stagnant pool of electrically conducting fluid. Incipient cavitation is strongly influenced by the presence of an axial magnetic field. The plunger is driven at ultrasonic frequencies and the magnetic field acts as a barrier against radial flow so it enhances cavitation effects.

An experiment aimed toward clarifying the ingestion of air bubbles into a liquid is performed under the direction of Professor H. Hashimoto and the experiment was shown to me by his assistant Mr. S. Sudo. A large beaker of fluid is shaken in the vertical direction by a mechanical shaker up to an acceleration amplitude of 20 g.

One more new facility was shown, a new low turbulence wind tunnel directed by Professor R. Kobayashi. It was constructed recently and it incorporates all the technical know-how available in the literature. The working section has a cross section of about 2 meters by 2 meters and it is about 6 meters long. It was build at a total cost of about $350,000.

There are several professors who are interested in initiating experimental work in turbulence, but at the moment there is no experimentalist with the necessary expertise in turbulence measurements. As it was explained to me, the main reason is the lack of a university position for such a young man. Upon my insistent questioning they said that the only solution is that the interested senior professors themselves will attempt to acquire the necessary experience with the measurement technique but this will certainly slow down the utilization of the new facility.

In addition to those described above there are other experimental facilities briefly mentioned by Professor Murai. One of these is a test stand for Francis turbines (Professor S. Saito); another is a shock tube tunnel (Professor M. Honda and Associate Professor K. Sakaya). There is work going on in supercavitation (Professor R. Oba), fluidics (Professor H. Hatanaka), and cavitation in oil (Professor S. Sato).

The other group concerned with fluid mechanics is the Department of Civil Engineering where Professor K. Kimura showed me the facilities. Naturally, here the orientation is more toward civil engineering applications namely free surface flows. Correspondingly most of the research is being carried out in a flume with three "legs," all using a common power plant. Each leg is dedicated to a different type of flow. One may be called a "regular" flow. Another one is used for studying sediment transport, and the third is for stratified flow. The density statification in the latter is achieved either by introducing a salt solution or by heating. The newest tool was recently introduced, namely LDV (Laser Doppler Velocimeter) to measure both horizontal velocity components in an effluent flow. The research themes actively pursued include studies of flow in porous media, experimental studies on soil erosion by rainfall, rheological properties of mud flow, etc. From the general orientation of the civil engineering department it is evident there is no duplication or even hardly any overlap between the work in the Civil Engineering Department and that of the High-Speed Mechanics Institute.

COOPERATIVE ELECTRONCIS RESEARCH IN SENDAI

Leslie S. G. Kovasznay

Research in electronics is pursued in Japan at many places, but in Sendai there is a rather interesting partnership between academic research and product oriented applied research. Within the University of Tohoku there is the Research Institute of Electrical Communication organized along conventional lines quite similar to the other eight research institutes. It has about 40 senior members (with the rank of Professor or Associate Professor) who are all engaged in research covering about 20 different areas of electronics. In addition to this academic type of research activity there is a semi-private organization, the Semiconductor Research Foundation that maintains a Semiconductor Research Institute (S.R.I.) located off-campus in surburban Sendai. This is a relatively unique organization for Japan so it deserves a brief description.

The Foundation itself was established in 1960 as an independent corporation. Its professed goal is "to pursue a pioneering position in bridging the gap between fundamental studies in research at the universities and the manufacturing developments conducted at various parts of the industries by focusing attention on the weak points in the interaction of our Japanese disciplines of science and engineering."

The founder of the Foundation was Professor Y. Watanabe, who has donated to the foundation all his patent rights in semiconductors and in related areas. The continuing support of S.R.I. is underwritten by the "Sponsors," about 20 large corporations who pledge a minimum financial support in return for certain privileges. These are mostly in the form of priority access to the research results and also the opportunity to exert influence on the trend of the research at S.R.I. This is accomplished through the sponsors representation on the Board of Trustees. In addition to this direct support S.R.I. also undertakes research on contracts from both government and industry since it has a greater flexibility than the national universities. In fact it has even more flexibility than do the private universities in Japan. One should also not fail to mention the fact that S.R.I. provides extra (and paid) research opportunities for junior faculty members of the university.

Currently, there are about 25 full time researchers aided by a limited supporting staff housed in the small but well equipped building within suburban Sendai. The annual budget of the whole operation is in the order of $500,000. It is quite natural that S.R.I. is very intimately connected with the Research Institute of Electrical Communication at the university. This is further emphasized by the fact that the present director of S.R.I. is Professor Jun-ichi Nishizawa, who is one of the senior professors of the University.

Professor Nishizawa is a very active, dynamic person and he received me on a Saturday morning when more than half of the staff was absent for the weekend. Professor Nishizawa has described a variety of solid state research problems with an applied electronics flavor. Among his many other accomplishments, in the late 60's he pioneered the focusing optical fiber. This optical fiber has a parabolic distribution of the optical refractive index and its application is of increasing interest in optical fiber communication plans. Professor Nishizawa showed me the original equipment that was used by him to produce focusing fibers with prescribed refractive index distribution. He also proudly displays to visitors the light emitting diode developed by his group. It is mounted with several others on a small panel clearly demonstrating that it outshines other commercial products (both U.S. and Japanese) when operated at the same electrical power level.

It is obvious to the visitor that Professor Nishizawa has an immediate grasp of the applicability of a newly discovered phenomenon. A good example is the suggestion that the self-focusing fiber offers the possibility of carrying an entire picture frame over a single fiber. One immediate application suggested is for intrauterine fetal

visualization as it is sufficient to introduce a single very thin fiber into the amniotic sac to obtain a picture of the fetus with an acceptable resolution.

At the present time the research of S.R.I. is centered on applications in several areas. Solid state technology such as development of transistors, photo-diodes, exploitation of new techniques such as ion implantation, semiconductor lasers, FET devices, etc. are all pursued. In optical communication both technology and application of self-focusing optical fibers and solid state lasers are in the programs. In addition to patentable processes and devices, industrial know-how has been developed and transmitted to the ultimate industrial user. The S.R.I. staff contributes about 30-40 full length research papers to the technical literature each year. Naturally the total scope of S.R.I. is small when it is compared to similar organizations in the United States. But in Japan where the cooperation between university and private industry is still in its infancy, this is a significant advance.

NIHON UNIVERSITY IN KŌRIYAMA

Leslie S. G. Kovasznay

Nihon University, one of the large private universities of Japan, was founded in the Meiji era in 1887. Its oldest Tokyo campus is located in the center of the city in Kanda, an area that is considered to be the heart of old Edo (the name of Tokyo before the "opening" of Japan to the West). The continuing expansion of the city and the skyrocketing real estate prices gradually suffocated the various academic institutions in the old part of the city. Consequently, Nihon University has spawned a number of satellite campuses in the greater Tokyo area. The most important of those is in Chiba, a distant suburb east of Tokyo Bay.

In addition to those in the greater Tokyo area, Nihon University has created an entirely new university campus far from Tokyo in the city of Kōriyama in Fukushima Prefecture. The city of Kōriyama is small by Japanese standards, having slightly over 100,000 inhabitants. It has an industrial character and although it is not a harbor, it is relatively close to the east coast of Honshu near the Pacific Ocean. It is located 225 km from Tokyo, about half-way between the capital and the bustling city of Sendai. Before World War II the leaders of Nihon University felt an important need for engineering education in that rapidly industrializing area, so in 1937 they established an engineering faculty in Kōriyama. This new engineering faculty in Kōriyama is quite independent of the one in Tokyo except for the fact that the chief executive of the University administers all campuses. Since in Kōriyama there is only a single faculty, namely Engineering, the Dean of Engineering, Professor A. Tonogi, is also the de-facto President, or Chancellor of that institution.

A few words may be useful about the power structure of the Japanese private universities. They are somewhat different from the American private universities operating as nonprofit institutions. The office of the president (Gaku-cho) of a Japanese private university corresponds much more to an academic vice-president in the United States then to the office of the president. This is so because in Japan the president's office does not include the responsibility for the financial operation of the institution. On the other hand the Board of Trustees (Riji-kai) have a more direct role in the financial operation and the Chairman of the Board of Trustees (Riji-kai-chō) holds the actual financial power. Another and a more subtle difference is that the members of the Board of Trustees (Riji) are generously compensated for their labor (at a rate that exceeds several times the salary of a senior professor). Because of this generous remuneration, the position of the trustees is often merely a sinecure for aging public figures who serve only to rubber stamp the decisions made by the Chairman of the Board. For this very reason the members of the Board of Trustees are usually quite reluctant to resign from the Board even in the case of a major controversy (as occurred during the large scale student disturbances in Japan around 1968). Furthermore, there is no effective mechanism to recall or remove them since in practice they are appointed (technically only proposed) by the Chairman of the Board so in a way they are their own "constituency" and for all practical purposes a self-perpetuating body.

If one adds to this the fact that the private universities in general do not qualify as nonprofit corporations, their financial and administrative character can be quite different from a typical American private university which must carefully satisfy the Internal Revenue Service about its nonprofit status and where the members of the Board of Trustees in general have no overt financial benefit from their position. Another important difference is that most of the private university's income is from tuition and entrance examination fees. The latter are quite high and as the ratio of admissions to rejections is very large, the end result is a sort of subsidy paid by those rejected to support the successful applicants. Since the private universities are so dependent on tuition, they are extremely vulnerable to pressures exerted by the prospective employers of their graduates. By this pressure they are constantly in danger of becoming mere "finishing schools" for the white collar workers (called "salary-men"

in Japan) who hope for a lifetime employment at some important large company. This economic pressure coupled with the strong academic dominance of the prestigious national universities make the private university's position quite precarious. Important reforms are difficult to bring about when the self-perpetuating Board of Trustees are in general quite content with the status quo. Nevertheless one finds refreshing exceptions to the rule.

Let us return to Nihon University in Kōriyama. In the local area it is the prestigious academic institution. Since the city is well beyond the commuting area of greater Tokyo, the faculty of engineering was able to develop its own independent character. The campus is large and attractive. The vital statistics are as follows:

Total area of the campus: 460,000 m^2.

The total floor space: 36,500 m^2.

The total enrollment is 5,400 students mostly undergraduates although there are about 50-60 graduate students.

The total teaching staff (including some administrators) numbers 200.

Departments are General Education, Civil Engineering, Architecture, Mechanical Engineering, and Chemical Engineering.

Due to its location the university receives less than its fair share of foreign visitors, so when I arrived Dean Tonogi was most kind and accommodating. In order to improve the efficiency of my visit most faculty members active in research (about 30-35 of them) were assembled in a conference room and each gave a short synopsis of his or her research. Their presentations were usually accompanied by slides; also I received numerous reports and reprints. About half of them spoke in English, half in Japanese. This procedure continued throughout lunch and a good part of the whole day. During the rest of my visit, the various laboratories were shown in the company of the same professors who gave the advance briefing at the assembly. Naturally, the subjects were extremely varied and the quality of the work presented was also somewhat uneven.

Beginning with fluid mechanics, the discipline I am most familiar with, the research of Associate Professor A. Ogawa of the Department of Mechanical Engineering should be mentioned first. He works both in swirling flows and in thermally driven free convection. In the last few years his primary interest has been vortex motion and its engineering applications. More specifically he has obtained important results both in the analysis and the experimental study of cyclone-dust-collectors. The basic and applied problems are connected in the following way. The dissipation mechanism in a turbulent helicoidal flow is intimately connected with the experimentally observable pressure drop necessary to maintain the proper flow through the cyclone device. Dr. Ogawa has been active in both aspects of the problem. He has a well equipped laboratory with the usual fluid mechanical instrumentation. The basic flow configuration uses a simplified geometry, a cylinder equipped with tangential intake in order to create the swirling flow and controlled out flow so that the axial flow component can be varied.

As far as the applied research is concerned, there is a fully instrumented cyclone-dust-separator in the laboratory where the engineering parameters can be measured directly under a range of operating conditions. The cyclone-dust-separator consists of an axisymmetric and nearly cylindrical vessel with its axis oriented vertically. The air enters tangentially in order to create a swirl in the vessel. Due to the high-speed rotation of the dust-laden air, the centrifugal force drives the heavier than air dust particles to the outer region while the purified air remains near the center. The purified air leaves the region near the axis through an outlet pipe reaching down along the axis from the top. The dust particles that migrated toward the outer wall are being slowed down by the boundary layer along the wall and they slowly descend to the bottom of the vessel where they are collected in a special container attached to the tapered bottom section of the vessel. The principal engineering question is, of course, how much purification can be achieved at what cost in power supplied to maintain the proper flow through the device. The flow in a cyclone device is a three dimensional turbulent shear flow with high turbulent dissipation. Dr. Ogawa calculated the turbulent dissipation as the product of a turbulent viscosity and the square of the vorticity. From experiments the relative distribution of the vorticity can be obtained. The flow consists of a core with nearly solid body rotation and an outer flow approximating a free vortex. The eddy viscosity obeys scaling laws and its distribution can be conjectured from the basic experiments carried out in the vortex tube. Being a high Reynolds number turbulent flow the eddy viscosity is essentially proportional to Reynolds number. It may be added that there is a special interest in dust collecting devices in Japan since there is a relatively larger use of diesel engines where the carbon particles have a higher concentration in the exhaust gas than in the case of

gasoline engines. Soon after my visit Dr. Ogawa went to Europe to give a paper on his work at the VII IUTAM Congress in Delft, Holland.

Professor K. Tanaka also in the Mechanical Engineering Department has made basic measurements of the viscosity of steam at high temperatures and pressures by using a capillary viscosimeter. Reliable data were obtained up to nearly 500 kg/cm^2 pressures and 700°C temperatures.

Professor F. Kito, also in the Mechanical Engineering Department, has developed a laboratory dedicated exclusively to hydroelasticity. The subject is analogous to aeroelasticity except for the working fluid. It is concerned with coupled oscillations of structures in various water flows. Professor Kito has written a monograph on the subject entitled "Principles of Hydroelasticity" (in English) published privately in 1970. The book gives a comprehensive survey of the field, dealing mostly with theory. The important problems treated are the vibration of cylindrical bars as well as of the walls of water tanks, that may be either closed or open with free surfaces. The important difference between the hydro- and aeroelasticity is the more important inertia effects in water due to the density ratio of 800:1 between the two media. Professor Kito was originally at Keio University, a prestigious private institution in Tokyo, and only after his mandatory retirement came to Nihon University in Kōriyama where he resumed his research program and rebuilt his laboratory equipment.

In the Civil Engineering Department Professor K. Kimura (he is also vice-dean of the school) has put forth a long, systematic effort to clarify the details of flow in rectangular ducts and open channels.

Also in the Civil Engineering Department Professors F. Kawakami and Y. Mori have studied the dynamic properties of earth dams and rock filled dams respectively. The question is especially important in Japan where earthquakes are more numerous than in any other highly advanced country. The fact that small tremors are rather frequent was utilized by the investigators as naturally given transient pulses to excite the structures. The selected dams were instrumented with accelerometers at several points and the output signals of those were recorded together with the seismic data. By computer analysis the response functions were obtained. The nonlinear nature of the response was clearly evident. At small amplitude excitation the damping of the oscillations was relatively weak or in other words the frequency response had high peaks at the natural frequencies. At high amplitude excitation the oscillations were more damped, suggesting higher order than simple viscous type of damping. At random excitation the natural frequencies of the structure were still clearly observable although the numerical values did not quite agree with the values computed from the geometry and assumed material properties (mainly the modulus of elasticity) of the dam.

In the Department of Architecture Associate Professor Y. Ohama is carrying out research on building materials. His special interest is concrete containing polymers. In general there are three types: first, polymer modified concrete for which polymer additives are introduced with the cement to modify the properties of conventional concrete. Second, resin concrete which is made without conventional cement, that is, sand and other aggregate is mixed with a resin (usually a polyester resin) which is then cured by heat. Finally, there is polymer impregnated concrete. This last one is a conventional cement-based concrete impregnated with polymer after the cement was set. Dr. Ohama has carried out a systematic study of these concretes and his results are reported in successive proceedings of the Japan Congress of Materials Research (held annually in Kyoto) and also were presented at the First International Congress on Polymer Concrete held in 1975. The variation of the mechanical properties with composition, the method of curing of the polymer, the response to fatigue tests and to impulsive loading all were considered. In many applications the physical properties of the polymer concretes appear superior to those of the conventional cement-based concrete by a factor of 3-8, so that even with the higher cost they may prove an attractive alternative, at least for premium applications, e.g., underwater pressure vessels.

Although the faculty at Kōriyama has no physics department as such and the Department of General Education provides instruction in the basic sciences, some of the science professors have succeeded in building up their individual research. Professor I. Ogura is a physicist who is active in research in a number of areas, such as: thin film properties and technology, effect of low energy electrons on surfaces, electron microscopy, and vacuum techniques in general. His laboratory is well equipped and he has a number of young collaborators. Among other things, he has studied the effects of mechanical (ultrasonic) vibrations during vacuum depositing

of thin films of silver, low energy electron irradiation effects on vacuum cleaved crystals, plastic deformation, and recrystallization of ultra microtomed thin slices of metal crystals. He has numerous publications, mostly in the Japan J. Appl. Phys.

To sum it up: the Faculty of Engineering of the Nihon University in Kōriyama, although a primarily undergraduate institution, was still able to initiate and maintain important research activities. This may be due partially to its distant location and ample resources but also largely to its ambitious faculty and successful management.

FLUID MECHANICS SESSION AT THE ANNUAL MEETING OF THE PHYSICAL SOCIETY OF JAPAN, UNIVERSITY OF NAGOYA

Leslie S. G. Kovasznay

This year the Physical Society of Japan held its large Annual Meeting at the University of Nagoya (Meidai) April 4-7. There were about 25 parallel sessions for three and a half days making a total of about 170 regular sessions and in addition some 30 "informal sessions" presenting about 2,000 papers. Some longer invited papers (about 45 minutes each) were given by well known scientists, but the majority of the papers were 10-15 minute contributed papers given by young research workers, mostly graduate students. There were several joint papers with the major professor as co-author, very much in the same manner as is the case with the American Physical Society. Since my comprehension of technical Japanese is limited, I attended only one day of the meeting, when papers on fluid mechanics were presented. A brief review of topics and authors is given below.

Statistical Fluid Mechanics: Professor S. Kuwabara, University of Nagoya (Special invited lecture); the author presented a rather personal approach to the theory of turbulence. A two-dimensional random flow field is decomposed into normal modes, those for rectangular boundaries become examples of cellular flow. The nonlinear interaction among the modes is calculated in a straightforward manner. Unfortunately the applicability of the method is limited to two-dimensional turbulence, a case that does not appear in nature, so the conclusions are interesting only from the point of view of the analytic technique.

Fluid Dynamics of Animal Motion: Dr. T. Kambe, University of Tokyo Aerospace Institute; a full length (45 min) review lecture dealt with a fascinating and multifaceted subject showing the influence of Sir James Lighthill with whom the author had spent nearly two years in Cambridge (1974-75). At the end of his lecture the author showed his recent measurements determining the shape of the section of the tailfin in the blue tunafish (the specimens were obtained earlier in a local raw fish restaurant or sushi-shop in my presence when we had lunch with Dr. Kambe). The interesting result is that the tailfin sections were found to be very close to a member of the popular NACA symmetrical airfoil series.

Noise Generation by Laminar and Turbulent Jets: Professor F. Sakao, University of Hiroshima; the work reported was done mostly in the Institute of Sound and Vibration Research, University of Southampton, England, where the author has spent more than a year. The spectra of the sound emitted from a circular jet were measured under two different conditions. In one case the boundary layer in the nozzle remained laminar and in the other case it was "tripped" and became turbulent. Interestingly enough the noise at least at higher frequencies (higher Strouhal numbers) was *higher* for the laminar boundary layer in the nozzle than for the turbulent case.

"Burst" Characteristics in a Turbulent Boundary Layer: S. Takagi, H. Saito, H. Sato; University of Tokyo, Aerospace Institute; the work was done under Professor Sato. The experimental technique somewhat followed the one used by W. W. Wilmarth (University of Michigan). Authors used truncated signals, i.e., separated the positive and negative portions of the two velocity fluctuation components u' and v' so that the separate contributions to the Reynolds stress by the four quadrants

$$\overline{u_+'v_-'} + \overline{u_+'v_+'} + \overline{u_-'v_+'} + \overline{u_-'v_-'} = \overline{u'v'}$$

be obtained in order to clearly indentify the "Burst" and "Sweep" phenomena.

Turbulence Scales in Density Stratified Flows: K. Tanaka, National Aerospace Laboratory; turbulence characteristics were measured in a specially constructed wind tunnel. By variable heating, density stratification was

achieved and in addition a velocity gradient was also imposed. The hot wire data has clearly shown the systematic variation of the spectra with Richardson number as a parameter.

Interaction between Vortex Rings Travelling along Parallel Axes: Y. Oshima, Ochanomizu University; new results were obtained by Mrs. Oshima showing the merger and again the subdivision of vortex rings that are generated simultaneously and travel side by side before interaction. The results were obtained by flow visualization.

Vortex Puffs: Professor K. Oshima, L. S. G. Kovasznay, T. Takemura and K. Ono, University of Tokyo Aerospace Institute; (Except myself) preliminary results were given on a research project I proposed and continue to supervise at Professor Oshima's laboratory working with two graduate students (Takemura and Ono). Turbulent puffs are vortex ring-like turbulent masses generated by an electrically pulsed loudspeaker equipped with a nozzle and turbulence generator. Detection of the recurrent (deterministic) portion of the flow is obtained by using phase locked ensemble averaging of the hot-wire signals over a large number of puffs by using a minicomputer.

Flow Around an Unsteadily Moving Elliptic Cylinder: Professor S. Taneda, H. Amamoto, K. Ishii, S. Takata, University of Kyushu; another one of Professor Teneda's beautiful flow visualization projects. The oscillating elliptical cylinder is placed into a steady flow and a sequence of vortices are shed, forming a beautiful but rather intricate pattern.

Vortex Experiments I and II: H. Honji and M. Tatsuno, University of Kyushu; two related papers were given by two collaborators of Professor Taneda. In one a travelling vortex ring was interacting with a density interface; in the other case two dimensional vortex pairs (the two-dimensional equivalent of a vortex ring) were generated and the influence of solid boundaries on them was studied.

Sidewall Effects on the Instability of a Liquid Film Moving on an Inclined Plane Surface: E. Hasegawa and Y. Shimizu, Keio University; it was found by the authors that for different ranges of the parameters different surface patterns were developing. Both a looped arc and the familiar criss-cross pattern were observed.

Source-sink Filtration Flow: Professor Y. Matsunobu, Keio University; theoretical calculations of the two-dimensional flow in a porous medium were reported. The boundary conditions were: circular domain with permeable boundaries, a separate source and sink produced the main input and output. The problem is said to be relevant to some biofluidmechanical situation, e.g., in the kidney.

General Comments: The session was well attended by the fluid mechanics community. In addition to attending the meeting, I had discussions with Professors Furuya, Uchida and Kuwabara, all of the University of Nagoya.

CONTRIBUTIONS FROM THE ANIMAL LABORATORY– DRUG AND RESPONSE INHIBITION[1]

Shinkuro Iwahara

Behavioral effects of drugs have been investigated with animals from many different aspects. Numerous contributions have been reported in relation to learning and memory, probably because of a theoretical interest and the easy availability of standard measuring techniques. Drug effects on innate behaviors such as fear, aggression, sexual behavior and spontaneous activity have been analyzed by many authors, but the definitions of these concepts and thus their measuring techniques are often different and sometimes not very logical. For example, immobility or freezing is often used as an index of fear but hyperactivity, the other end of the same continuum, is equally often used without any explanation. Drugs which are shown to inhibit conditioned fear are sometimes assumed to suppress "conditioning" or memory process rather than innate fear itself.

Drugs also have important effects on specific homeostatic drives such as hunger and thirst, as well as on the reinforcement mechanism as monitored by the self-stimulation method. Nonspecific general arousal is increased by some drugs called "stimulants," while it is decreased by other drugs called "depressants." In addition, drugs such as cholinergics are assumed to affect more specific inhibitory mechanisms, including suppression of unrewarded or punished responses.

Like other external and internal stimuli, drugs sometimes have discriminative stimulus properties and this phenomenon, often called drug-state dependency or drug-learning dissociation, is one of the recent most challenging issues in psychopharmacology. Related to this problem is drug dependence or addiction in that some drugs have very strong reinforcing effects. Neither of the two phenomena has ever been clearly explained in terms of their underlying mechanisms. Finally, sensory and motor mechanisms are also affected by some drugs, and for this reason these peripheral effects must be well controlled in most psychological research in order to evaluate drugs' central actions.

So much for the current main topics in animal psychopharmacology. The primary purpose of this article is to cover, very briefly, what has been done in our laboratory during the past ten years. The drug which we used most frequently is chlordiazepoxide, the most representative benzodiazepine, and because of its anxiety-reducing efforts it is now widely used clinically for the treatment of various neurotic manifestations. Originally this agent was known to reduce aggressive behavior and conditioned avoidance in animals and its main action was believed by Randall et al. (1960) and Tobin et al. (1960) to be on affective processes. However, a series of our experiments with this drug has convinced us that its main action is a disinhibitory effect like that of atropine and scopolamine and many of the behavioral effects produced by these drugs can also be reproduced by hippocampal and other limbic dysfunctions. In addition, both benzodiazepines and anticholinergics have a relatively strong stimulus property such that animals can easily discriminate between the drug and control placebo states (Overton, 1972). We have investigated this drug-state dependency using chlordiazepoxide (CDP) in many different situations (Irisawa et al., 1976; Iwahara, 1971; Iwahara et al., 1967; Iwahara and Noguchi, 1974; Iwahara and Sugimura, 1970; Oishi et al., 1972), but this paper will be restricted to the disinhibitory effect of CDP. I will sample eight representative experiments, not necessarily in temporal order, from our ten-year work on CDP's disinhibitory function.

[1]This is a summary of a paper presented at the Symposium called "Pharmacology and Behavior" organized by Dr. J. R. Wittenborn, as part of the academic program of the XXIst International Congress of Psychology, held in Paris on July 22, 1976.

In Experiment I, hungry rats were trained to run for food in a simple straight runway for 17 days with a total of 64 trials. In this rather restricted situation, partial reinforcement or 50% reward is shown to facilitate running speeds as compared with continuous reinforcement of 100% reward. This is due to the fact that nonreward will produce frustration in rats, which, in turn, has a general motivational factor and thus will increase the animal's on-going motivation (hunger) and consequently its running speeds. If CDP has a disinhibitory effect, it will reduce the frustration or inhibition produced by nonreward and thus partial reinforcement will slow rather than facilitate running speeds because of a lower rate of reinforcement (Iwahara et al., 1966).

In the second part of the experiment, rats were trained under the same experimental setup and after 17 days of acquisition trials they were given 4 extinction trials (no reward) per day for 8 days. CDP is expected to slow the extinction ratio because the inhibitory factor due to extinction or nonreward will be disinhibited by the drug (Iwahara et al., 1967).

In accordance with the drive-increment theory of frustration, the 50%-reward group ran faster than the 100% reward group on the last 2 days under the control saline condition. But this partial-reinforcement effect in acquisition was reversed by CDP at 20 mg/kg given i.p. 30 minutes prior to daily trials. This finding supports our disinhibition hypothesis of CDP. The drug effect was small at 10 mg/kg and thus we have a dose-response relationship.

When we consider only those groups of rats run under the same drug or saline state (drug-drug or saline-saline) in acquisition and extinction, a slower extinction rate was produced under CDP whether the rats had been given 100% or 50% reward in acquisition, and thus our disinhibition hypothesis is again confirmed. In addition, there was a distinct drug-learning dissociation or drug-state dependency in that extinction was always slower under the same state than otherwise.

In Experiment II (Iwahara et al., 1972), we tested the disinhibition hypothesis in spontaneous alternation in a T maze. This phenomenon or a tendency to spontaneously alternate responses on successive trials is usually ascribed to response inhibition or similar inhibitory factors. Thus if CDP has a disinhibitory action, it will reduce the amount of spontaneous alternation. Results indicate a clear reduction of alternation under CDP, which was even below 50%, probably due to the drug's facilitation of the rat's dominant position preference. The median time between successive trials was shorter in CDP rats. A decrease in intertrial intervals is already known to increase rather than to decrease spontaneous alternation and thus the obtained result cannot be ascribed to the time variable.

Experiment III was designed to test the disinhibition hypothesis based on a discrimination task (Iwahara and Sugimura, 1970). Rats were trained to discriminate between black and white by escaping or avoiding electric shock in a Grice-type discrimination chamber. Training continued until a criterion and from the next day, black-white cue values were reversed and training lasted to the same criterion. Half the rats were given CDP and the rest saline. In reversal learning, each group was likewise divided into CDP and saline rats.

Results indicated little drug effect on the original discrimination learning but, regardless of whether rats had been treated with CDP or not, CDP rats were inferior in reversal learning; that is, they failed to inhibit the previously reinforced response in the cue-reversal situation. In addition, there was a clear-cut drug-state dependency and running time was hardly affected by CDP in this experiment.

In Experiment IV (Iwasaki et al., 1976), one group of rats were given a successive discrimination task in which they were required to respond by going right or left, depending on whether both stimulus doors were black or white. This successive discrimination is more difficult than the simultaneous discrimination mentioned in Experiment III with the same black-white contrast, since rats are required to inhibit the previously correct response when it is not correct on the successive task, while the correct response is always identical with respect to cue values on all trials on the simultaneous task.

One group of rats were trained on the successive black-white discrimination and another group of rats were similarly trained on the simultaneous black-white discrimination task. Based on a pilot study, black-white contrast

was changed such that both discriminations were about equal in difficulty. This was necessary in order to evaluate CDP's effect on two types of discrimination learning rather than on different degrees of learning.

Because of the changed black-white contrast, saline rats took about an equal number of trials to learning criterion on both tasks and thus the drug effect can be directly compared. As was the case in Experiment III, CDP's depressant effect was small and not statistically significant, but it markedly retarded successive discrimination. A further analysis indicated that this depressant effect was largely due to the dominant position preference in CDP rats as was the case in our alternation study (Experiment II).

Unfortunately, the result could also be explained in terms of the drug's inhibitory action on the use of proprioceptive cues which is necessary only in successive discrimination. In order to eliminate this factor, Experiment V (Iwaski, 1976) was designed in which hungry rats were run in a straight runway as in Experiment I and they were rewarded with food on half the trials (when the alley was dark and the goal-box door was black), and not rewarded on the other half of the trials (when the alley was bright and the goal-box was white). The stimulus cue values were reversed for half the rats. On the nonrewarded "no-go" trial, the animal was replaced as soon as it touched the closed goal-box door or 30 seconds after the start-box door was raised, while on the rewarded "go" trial, the rat was removed from the goal-box immediately after eating food. Thus in this situation the animal was not required to use any particular proprioceptive cues as in Experiment IV. As predicted, CDP rats ran much faster than saline rats on the "no-go" trials, that is, they failed to inhibit or withhold the nonrewarded "go" response, although both groups performed almost equally on the "go" trials.

In Experiment VI the same disinhibition hypothesis was tested in a similar situation but with monkeys (Hasegawa et al., 1973). That is, monkeys were trained on a "go/no-go" type red-green discrimination task following saline injections, using a modified WGTA. Two measures were taken per trial: one was response latency and the other was whether the response was right or wrong. The response was called correct either when the animal displaced the positive cover for food within 5 seconds or when the animal did not touch the negative cover during the 5-second interval.

After reaching a 90% correct criterion on a single day, the monkey was tested with 20 mg/kg of CDP either on the same successive task or on the simultaneous task in which both red and green covers were presented simultaneously with an inter-stimulus interval of 30 cm. A raisin (food) was concealed only under the cover which had been positive previously. Two days later, the animal was again trained under saline on the original successive task to the same criterion. One day after the criterion was met, the monkey was given a second drug test on the simultaneous or successive task which was not given previously as a test task.

On the successive task test, all responses to S+ were correct both under CDP and saline but percent correct to S- was only 61% under the drug in comparison with 88% under saline; mean response latency to S- was less under CDP than under saline but this relation was reversed with respect to S+. The latter effect may be ascribed to CDP's muscle relaxant action and the obtained result cannot be explained in terms of the drug's depressant effect on red-green discrimination itself since no drug effect was observed on the simultaneous discrimination task.

Experiment VII was carried out to evaluate our hypothesis on passive avoidance (Oishi et al., 1972) and on shuttle avoidance (Iwahara, 1971). In the former test, rats were placed in the larger part of a two-compartment apparatus and were shocked as soon as they entered the small compartment; they were tested for retention without shock two days later. In the shuttle avoidance test, rats were given 15 trials per day and learned to avoid electric shock by running to the next compartment within 5 seconds after the sound signal started. Training continued until a 13/15 avoidance criterion on a single day or until the 12th day when the criterion was not attained. Half the rats were given CDP and the other half were treated with saline in both tests. In summary, CDP inhibited passive avoidance, while it facilitated shuttle avoidance. This result is interpreted in terms of our hypothesis to the effect that CDP failed to inhibit the rat's entering into the previously shocked compartment in both tests.

In Experiment VIII we tested our disinhibition hypothesis in classical heart rate (HR) conditioning (Yamaguchi and Iwahara, 1974). Rats were presented either a 500 Hz or a 2000 Hz for 5 seconds, 10 times each and

only one of the tones was always followed by a short electric shock. Animals were injected either CDP, saline, or nothing. As the latter two conditions gave the same results, these were pooled as controls. This differential HR conditioning is a successive tone discrimination, and the normal rat is expected to respond only on the S+ trial, which was the case in our control rats. On the other hand, CDP rats responded almost equally to S+ and S-, that is, they responded even to the nonrewarded stimulus in accordance with our disinhibition hypothesis of CDP. However, CDP rats did respond to the tones almost as early as control rats, and this result suggests that simple HR conditioning or fear conditioning itself was not affected by CDP.

From the above eight experiments and others conducted in our laboratory over the past ten years, we may conclude that CDP has a powerful disinhibitory effect in attenuating various types of inhibition, whether it is produced by nonreinforcement, punishment, or response itself.

As we have already noticed, anticholinergics such as atropine and scopolamine have a similar disinhibitory effect (Carlton, 1969) but their sites of action may be different. One such possibility was claimed by Stein (1969). He assumed a punishment or inhibitory neural system in addition to the reward or facilitatory neural system in the brain. The former includes the periventricular pathway through the medial diencephalon and midbrain activated by *cholinergic* fibers from the limbic forebrain, and *serotonic* fibers from the brain stem raphé. Stein argued that anticholinergics disrupt the cholinergic system and benzodiazepines impair the serotonergic system of the same inhibitory pathway and thus both anticholinergics and benzodiazepines have the same disinhibitory property. Related to this assumption is the evidence that lesions of the hippocampus, septum, olfactory bulbs and medial hypothalamus produce a similar disinhibitory effect (Isaacson, 1974), indicating that these drugs may act differentially but at least on one of the structures which are closely interconnected.

In addition, the hippocampus during its characteristic theta activity is often assumed to have an inhibitory function, although there are many other views (Bennett, 1975). This assumption is based on the findings that lesions of medial septum, medial hypothalamus and, of course, hippocampus abolish theta activity in the hippocampus and at the same produce disinhibitory effects. However, our recent studies show that lesions of medial septum (Senba and Iwahara, 1974) and of olfactory bulbs (Iwahara and Kato, 1975) have similar depressant effects on orienting responses in drinking rats. That is they fail to inhibit the on-going motivated behavior when tones are presented, but hippocampal theta activity is abolished by septal lesions but not by bulbar lesions.

Moreover, although anticholinergics and benzodiazepines may have a similar disinhibitory effect on behavior, their effects on hippocampal electrical activity seem to be considerably different. We have shown that CDP slowed theta frequency and increased fast activity at the doses when its disinhibitory action is observed (Iwahara et al., 1972). On the other hand, atropine does not affect theta frequency during movement and it even increases theta frequency during paradoxical sleep (Usui and Iwahara, 1977). Thus we may conclude that although benzodiazepines (CDP) and anticholinergics (atropine) have some common behavioral effects, their sites of action seem to be considerably different.

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THE 24TH ANNUAL SYMPOSIUM OF THE SOCIETY OF RHEOLOGY, JAPAN

E. A. Kearsley

Since I am a rheologist, I joined the Society of Rheology on arrival in Tokyo as a natural way to immerse myself in scientific Japanalia and I was therefore pleased as well as honored to receive an invitation to talk at the Annual Symposium. I admit to a small flicker of doubt, however, when I saw the English title of my little talk buried in pages of Japanese symbols.

The First Rheology Symposium was held in 1952 under the joint auspices of the Chemical Society of Japan, Physical Society of Japan and Society of Polymer Science, Japan. Since then, a Rheology Symposium has been held annually except for 1950 and 1958. The papers given at these meetings have been published by the Japan Society for Testing Materials (later Society of Materials Science, Japan). The Society of Rheology did not exist until 1972, four years after the Fifth International Congress on Rheology was held in Kyoto. Since its inception, it has been the organizer of the Annual Rheology Symposium.

The Society of Rheology, Japan, despite its relative newness, is very like its U.S. counterpart. For instance, the membership of over 400 (including some student members) is roughly in proportion to the 850 members of the U.S. Society of Rheology. The membership is drawn from many fields, but, like the U.S. Society, it has a particularly strong representation from polymer interests. It publishes the *Journal of the Society of Rheology, Japan*, which appears irregularly, but about three times a year. Although the Journal is published in Japanese, abstracts of articles, legends and captions of figures are in English. It is possible for an experienced rheologist to get the gist of most articles from these English aids, and that is apparently the aim of the editorial policy.

In any event, I arrived in Maebashi, Gunma prefecture, on a Thursday evening in October after a train ride of about an hour and a half from Tokyo. I had no trouble checking into my hotel, but on the following morning I realized that the instructions for getting to the meeting were all in Japanese, and though the hotel was full of visiting swine-breeders from Iowa, not a rheologist was in sight. Nevertheless, with the help of an English speaking bellhop and a little tourist "Nihongo" it was possible to find the bus route to the campus of Gunma University where the Symposium was held. This area is in a tongue of the Kanto plain surrounded by low mountains on three sides. It has unusual scenery for Japan and in the clear autumn weather it reminded me slightly of the western United States.

The Symposium consisted of unsplit sessions so that it was possible to audit all of the papers. (This is a luxury the U.S. Society of Rheology sadly abandoned some years ago.) The meeting was marked by good attendance throughout, including the last session on Sunday afternoon. On Saturday, there was an outing to Akagisan, a famous local mountain quite beautiful in the fall colors, followed by a pleasant buffet with drinks and discussion reminiscent of the many "smokers" I have attended at U.S. Rheology Society meetings.

The formal sessions were smoothly run (exactly on time like the Japanese railroad trains) and a proceedings with four page preprints of each paper had been supplied on my arrival at the meeting. Unfortunately for me, the Journal policy on English captions was not followed in this case, and my impression of the papers depended on a scattering of English words or subsequent informal conversations. The following program with occasional short notes based on these clues represents my interpretation of what occurred.

1. Measurement of nonlinear dynamic properties of polyethylene films with a new apparatus; S. Onogi, K. Tanaka, M. Fukada–Kyoto University. An apparatus for dynamic extensional deformation was used. Data for mechanical and birefringence measurements were displayed as a function of amplitude of deformation.

2. Deformation dependence of the viscoelastic behaviour of plasticized PVC film; T. Kawabata, T. Akewatari, Y. Takarazeki–Kyoto University. Large biaxial deformations were used to study stress-relaxation, viewed as time-dependent finite elasticity. Poisson's ratio was measured to evaluate volume effects.

3. Extensional properties of styrene–acrylonitrile copolymer; H. Ninomiya, E. Kamei, S. Hoshino–Ube Industries, Ltd.

4. Viscoelastic behaviour of poly (isobutylene oxide) subjected to UV degradation; M. Yoshinari, K. Murakami–Tohoku University.

5. The effect of fatigue in extension on the work function of vulcanized rubber; T. Kusano, K. Murakami–Tohoku University.

6. Chemo-rheology of an uncrosslinked amorphous polymer; K. Murakami, K. Nakanishi–Tohoku University.

7. Mechanical properties and morphology of solution-spun fibers of S rich SBS block copolymers; H. Itoh–Gunma University.

8. A review of work on composite materials; T. Hata–Gunma University. This was an invited talk published in Kagaku Zasshi (Chemistry Magazine) in Japanese.

9. Complex effects in rubber composites; K. Fujimoto–Bridgestone Tire Co., Ltd. Through description of the microscopic morphology, the effects of carbon black and carbon fibers were elucidated in this invited talk.

10. Viscoelastic properties of uniaxially oriented FRP; T. Kawabata, T. Takarazeki, T. Matsuda–Kyoto University and H. Sagami–Toyota Automobiles, Ltd.

11. A comparison of torsional and tensile dynamic properties of composite aromatic polyimide–carbon fiber material; H. Kambe, M. Kodii, K. Oikawa, H. Kori–Tokyo University (Institute of Space & Aeronautical Science). A Rheovibron and a commercial torsional-braid analyser were used to scan in temperature at a fixed frequency.

12. On residual stress and its relaxation in an iron-epoxy-iron adhesive joint; T. Kawabata, M. Matsuda, Y. Takarazeki–Kyoto University. A "poker chip" joint was used with epoxy between two iron disks.

13. The onset and growth of peeling fracture; K. Igarashi–Gunma University. The model of Rivlin and Thomas was extended and applied to the peeling of canvas with a rubbery adhesive.

14. The composite structure of wood and its stress relaxation; T. Ohkawa, T. Yamada–Kyoto University (Wood Research Institute).

15. The numerical analysis of a flow for wire coating in a die; K. Fuse, K. Orimo–Furukawa Electric Co. Ltd.

16. Sound velocity in a system of dispersed spherical particles; T. Takano–Gunma University, A. Sakanishi–Tokyo University. A calculation was done for an array of viscoelastic spheres.

17. Synovial fluid, its viscoelastic properties; T. Tateishi, H. Furue, Y. Shirosaki, Y. Miyanaga–Ministry of (MITI) (Mechanical Engineering Lab.).

18. Viscoelasticity of blood; M. Kaibara, E. Fukada–The Inst. of Physical & Chemical Research. A new device was described using a capillary flow to measure dynamic properties.

19. The piezoelastic, dielectric and elastic properties of bone as a function of temperature and water content; H. Maeda, K. Tsuda–Research Institute for Polymers & Textiles, E. Fukada–The Institute of Physical & Chemical Research.

20. The rheological properties of liquid crystals–initial structure and flow of cholesteric liquids; T. Asada, H. Matsumura, T. Shibahara, S. Onogi–Kyoto University.

21. The rheological properties of polyacrylamide titanate fiber suspensions in water; Y. Mikami–Sekisui Chemical Co., S. Onogi–Kyoto University. This paper discussed the use of a Weissenberg Rheogoniometer with such suspensions.

22. On the dilatant behaviour of titanium dioxide–water suspensions; K. Umeya, T. Sugano, S. Itoh–Tohoku University.

23. On the rheopectic behaviour of titanium dioxide–water suspension; K. Ueya, T. Sugano, H. Igarashi–Tohoku University.

24. Some problems of the liquid crystal state of pitch; S. Ohtani–Gunma University. This was an invited talk by the originator of a patented method of making carbon fibers from pitch.

25. Flow properties of fluidized beds; O. Kikuchi, H. Machida, N. Ototake–Tokyo University of Agriculture & Technology. A discussion of gas fluidized beds of liquids and of emery and quartz particles.

26. Flow properties of tobacco powder–water systems; Y. Shimizu, T. Tujita–Japan Monopoly Corp., K. Umeya–Tohoku University.

27. A relation between the flow of powders and the shape of hoppers; A. Takami, Yamawaki Gauen University.

28. The Raised Cosine Pulse Method of viscoelastic measurement; K. Umeya, T. Isoda, T. Otsubo, T. Yasue–Tohoku University. The response to excitation by one cycle of the form $(1 - \cos t)$ is examined.

29. Rheological properties of soap bubble foam–An apparatus; H. Komatsu, Y. Yamada, M. Fukushima–Shiseido Laboratories. The oscillations of a mass-spring combination are damped by the foam.

30. Non-Newtonian effects in a sliding cylinder viscometer; K. Tachibana, J. Yoshikawa–Fukui University. This is a calculation of the associated flow problem.

31. Rheo-optical studies of concentrated solutions of PBLG, steady and time-dependent behaviour and molecular orientation; T. Asada, H. Matsumura, Y. Shibahara, S. Onogi–Kyoto University.

32. Reverse thixotropy of polymethyl acrylic acid/water solutions; K. Ono, K. Murakami–Tohoku University.

33. Dynamic properties of amylose and amylo-pectin mixtures; M. Nakamura, T. Amari–Tokyo University (Institute of Industrial Science).

34. Rheological properties of solutions of styrene–isoprene block copolymers; Y. Matsumoto, S. Katsuno, T. Matsumoto, T. Matsuda, S. Onogi–Kyoto University.

35. Viscoelastic properties of styrene–MMA block copolymers; T. Kitamura, S. Yamamoto, T. Masuda, S. Onogi–Kyoto University.

36. The elastic fluid (BKZ fluid) in theory and experiment; E. A. Kearsley—ONR/Tokyo. An invited talk by an expert from out-of-town.

37. Modifications of the Weissenberg Rheogoniometer to measure transient normal-stress differences; M. Takahashi, T. Masuda, S. Onogi—Kyoto University.

38. A Measurement of transient normal-stress difference by means of flow birefringence; N. Bessho, A. Murai, K. Osaki, M. Kurata—Kyoto University (Institute for Chemical Research). A study of start-up and cessation of steady shear.

39. On the flow of a viscoelastic fluid at a capillary exit; R. Nakamura, N. Yoshioka, T. Jinbo, S. Fujimune—Kyoto University.

40. An experimental study of the unstable flow of a high polymer solution; M. Nomura, K. Koyama, K. Funatsu, H. Shinohara—Kyushu University. This paper related to "melt-fracture" phenomena on extrusion.

41. Non-Newtonian behaviour of dilute polystyrene solutions; Y. Itoh, T. Kondo—Niigata University. This was an examination of concentration effects using a capillary viscometer.

LYMPHOID CELL INTERACTIONS AND THE IMMUNE RESPONSE IN JAPAN 1976

James N. Woody

SUMMARY

A small group of scientists met in Kyoto, Japan to discuss how lymphoid cells interact to produce antibodies and perform other cellular immune functions. Evidence was presented showing that individual subsets of cells are responsible for separate functions, and that these cells can be identified by their unique lymphocyte surface antigens (Ly-antigens). It was also shown that cells interact via biologically active molecules (factors) that transmit information resulting in either enhancement or suppression of antibody production, depending on the antigenic stimulus. A number of researchers were able to demonstrate that genes controlling both the production of these factors, and their acceptor sites, could be mapped to distinct segments of certain chromosomes.

Evidence was also presented suggesting that the antigen specific receptors found on all lymphocytes were coded for by the same genes controlling the variable regions of the immunoglobulin molecules, although the molecular nature of these antigen specific receptors remains the subject of continued controversy.

A symposium on "Cell Interactions in the Initiation and Regulation of the Immune Response" was held in Kyoto, Japan, September 1-4, 1976. The meeting was organised by Dr. Y. Yamamura and Dr. Y. Hamashima and held under the auspices of the International Union of Immunologic Societies, the Japanese Society for Immunologists, and the Ministry of Education in Japan.

The symposia organisers selected beautiful Kyoto, the ancient capital of Japan, as the site for this meeting, where about 200 researchers, two-thirds being Japanese, met with European and American scientists to exchange ideas in this rapidly expanding field.

It was, appropriately enough, the ancient Chinese who practised "variolation" (immunizing a person with material from a smallpox pustule) as a method of inducing immunity to smallpox; the procedure was dangerous, but effective, and preceded Jenner's cowpox inoculations by many centuries. It was not until the mid 1800's that scientists began to recognise that certain serum components contained protective antibodies, and it was not until the early twentieth century that antigen (molecules that stimulate antibody production) antibody interactions were studied in any detail. In the past few decades, investigations have revealed that antibodies are complex globular glycoproteins that have the unique property of combining specifically with the inducing antigen, and are produced by a special class of lymphoid cell known as a plasma cell.

In the mid-1960's, it was learned that certain lymphoid cells must interact if antibody is to be produced, both 'T' lymphocytes (derived from the thymus gland) and 'B' lymphocytes (bone marrow derived presursors of plasma cells) are required for antibody to be produced against most antigens. In the short time since these facts were uncovered the evidence for cell interaction in the immune response has proliferated until almost every immunological activity involves the interactions of several distinct cell types and their products. The symposium held at Kyoto covered the entire spectrum of modern cellular immunology; a few of the most interesting aspects of this meeting will be reported here.

Lymphoid cells have a number of surface glycoproteins that are antigenic when injected into other members of the same species; these are called alloantigens. When cells from one strain of animal are injected into

another strain antibodies against these different antigens are produced, and the immune serum is called an alloantiserum. Alloantisera raised in this manner have allowed workers to subdivide lymphoid cells by their surface antigens. 'T' cells for instance all carry a particular alloantigen called Thy-1, whereas 'B' cells do not. Another series of 'T' cell alloantisera was described in 1968 by Boyse and his colleagues in New York. These alloantisera were directed against antigens only on lymphocytes and hence were called 'Ly' alloantisera. Harvey Cantor, of Harvard, reviewed how these Ly alloantisera have been used to probe the T lymphocyte pool. He explained that T cells are necessary for antibody to be produced, and that they can either enhance antibody production, or suppress it. T cells are also capable of becoming killer cells that can destroy certain foreign cells. Cantor and Boyse have done collaborative studies, using the Ly alloantisera, to show that helper T cells carry a surface antigen called Ly-1, while suppressor T cells and killer T cells do not; the latter do however, have Ly antigens 2 and 3 (Ly-2,3) on their surface, which are not present on helper cells. Others have shown that precursors also carry the same antigens, which allows us to postulate the differentiation scheme as is shown in Figure 1.

Cantor also described a series of ingenious experiments showing that once a cell had reached the precursor or effector stage it could no longer return to a more primative or less differentiated stage. Hence these alloantisera have made it possible to show that functional cells differentiate along different distinct paths, rather than the same basic cell performing different functions as it matures. Other workers presented evidence showing that killer cells and suppressor cells carry different antigens and hence are different cell types. The writer, formerly of the Naval Medical Research Institute, Bethesda, Md., and now at University College, London, discussed the current status of new Ly alloantisera, and how they may be used to further characterize functional T cell populations. Marc Feldmann of the University of London presented an enormous amount of information concerning the methods by which cells communicate. Studies by him and his colleague, Peter Erb, have shown that macrophages, when stimulated with antigen, produce a biologically active molecule that binds to T cells, causing them to differentiate and become helper cells. The helper cells in turn produce molecules that signal the appropriate B cell to differentiate into antibody secreting plasma cells. These biologically active factors are very specific for the antigen that induced them. With a series of clever experiments they found that the genes coding for production of the factors by macrophages, and for the acceptor site on the T cell, are to be found in the Immune Response (Ir) region of the H-2 chromosomal segment on the seventeenth chromosome of the mouse.

Fieldmann also discussed work on factors produced by T cells that induce suppression. However, this was dealt with in greater detail by Dr. Tada, of Chiba University, Japan, who presented information on a biologically active suppressor factor that was antigen specific. Tada and his collaborators, L. Hertzenberg and D. Murphy of Stanford were able to map the genes responsible for the production of this factor to the Ir region of the H-2 chromosome of the mouse.

Don Shreffler of St. Louis explained that on the seventeenth chromosome of the mouse is a small segment known as the H-2 region. The genes (segments of DNA directing protein synthesis) within this region control the production of certain cell surface alloantigens known as H-2 antigens, that are present on all cells. These antigens are very strong and turn out to be the ones responsible for the foreignness when skin or kidney transplants are rejected and are therefore known as the major histocompatibility antigens. Man has a similar group of antigens known as HLA antigens. Within this H-2 segment of chromosome are a series of genes that control the ability of the animal to produce antibodies to certain antigens; these are the so-called Immune Response (Ir) genes. They also control the production of certain surface antigens known as Ia antigens. The method by which Ir genes control the immune response is not known; however, much interest was generated when it was learned that the genes coding for these helper and suppressor factors are found in the Ir region.

K. Rajewsky of Köln presented information on the lymphocyte antigen receptor, an area of long standing controversy. It is well known that B cells have immunoglobulin on their surface that binds antigen and acts as an antigen receptor. Since T cells have no detectable immunoglobulin on their surface the nature of the T cell antigen receptor has been highly speculative. The portion of the immunoglobulin molecule (variable region) where antigen is bound, is unique for each antigen. Using specially purified antibodies, Rajewsky was able to make antibodies in guinea pigs directed against this unique antigen binding site (anti-idiotype antibodies) in mice and show that the anti-idiotype antibodies would stimulate T cells, thus providing strong indirect evidence that T cells have at least some form of immunoglobulin variable region on their surface, and that the T cell antigen receptor is in part coded for by the same genes that code for immunoglobulin variable regions.

One might reasonably ask what all this means in terms of practical scientific benefits. The answer lies in the fact that over the past decade the number of diseases found to exhibit immune abnormalities has increased astronomically, ranging from acute viral infections to rheumatoid arthritis and cancer. Our knowledge of how the immune system operates, what the feedback mechanisms are, and how things go awry in these diseases is only beginning to be applicable. Although we currently use a number of nonspecific measures to modify the clinical course of these diseases we shall not be able to alter or prevent them in a significant fashion until the basic immune mechanisms underlying the abnormalities are understood. The knowledge gained from the study of immune functions in animals has been shown in the past to be applicable to the human immune system, hence the continuing probe into these animal systems will provide us with leads and ideas that will perhaps allow us to manipulate the human immune system in a beneficial manner.

Many other excellent papers were presented, most dealing with various specific facets of cell cooperation. The meeting was extremely well run with, for once, adequate time for questioning and discussion. The Japanese were absolutely superb hosts making the meeting not only a scientific success but a pleasant experience long to be remembered.

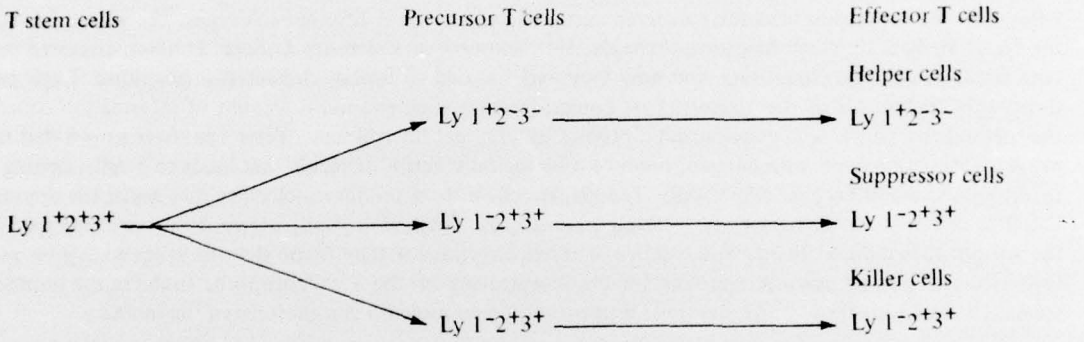

Figure 1. Differentiation scheme of T cells as analysed by surface Ly antigens.

A NONTECHNICAL REPORT ON THE WORKINGS OF THE JAPAN METEOROLOGICAL RESEARCH INSTITUTE

Morton A. Bertin

The writer is unqualified to provide technical information on the research underway in the following two Institutes. These reports are for those who might find a brief review informative in terms of the general areas under study.

The Meteorological Research Institute is housed in rather ancient quarters in what the Japanese call a bedtown section of Tokyo, meaning an area which houses people who work in the central city and return to their homes only to sleep. This may be something of an oversimplification, but the neighborhood did appear to be somewhat deserted during my visit to the facility. The Institute plans to move to Tsukuba Science City in a few years, looking forward to better quarters and more sophisticated equipment. Also available to them will be a new computer, now in the process of being installed by the Japan Meteorological Agency in Kiyose, a section of Tokyo.

Dr. Ken Suda, the Director (who studied at New York University), and members of his staff provided a review of the operation. They operate on a budget of about three and a half million dollars a year which covers all expenses including the salaries of 142 scientists. The Institute is an arm of the Japan Meteorological Agency, part of whose function is to coordinate the national meteorological service through meteorological, terrestrial, and hydrological observations and the collection and dissemination of information. The Agency also cooperates in the world network by participating in the World Weather Watch Plan to provide warning of potential natural disasters. The Agency was established in 1872 and the first weather station was set up in Hakodate on the site of what is now the Hakodate Marine Observatory. The first daily weather reports were issued from the Tokyo Meteorological Observatory, which was established in 1875.

The Institute, which traces its origin to 1942 as a research division, assumed its present identity in 1947. It presently consists of nine divisions conducting research in various fields related to meteorology including earthquake prediction, atmospheric phenomena, volcanoes, the hydroenvironment, and it is also involved in the research and development of meteorological observation equipment.

The Forecast Research Division is concerned with the physical structure of weather phenomena, seasonal forecasting and climate, weather analysis, and physical structure of weather phenomena. They have completed two numerical simulations of winter climate, one of the ocean and the other of the mountain effects. Figures displaying the surface pressure distributions developed from these were shown, the conclusion being that the mountains are more critical in establishing winter weather patterns for Japan.

The Typhoon Research Division deals with typhoon structure and formation, disasters, and the radar-detectible-cloud physics of typhoons. Here also simulation techniques are used to better understand the nature and mechanism of tropical cyclones. It was shown how the summer monsoons of India and Southeast Asia influence the climate of Japan and the Far East. Temperature and wind maps have been drawn showing weak and active monsoons over India.

In the Physical Meteorology Division the primary areas of study are clouds and precipitation physics, atmospheric turbulence, topographical effects on wind, and atmospheric particulates. To study clear atmospheric turbulence in airports close to mountainous areas, the researchers use field observations as well as wind tunnel

experiments. They have also developed new instrumentation to investigate atmospheric turbulence in the planetary boundary layer. Through the use of a membrane filter method a long range study of ice nucleus concentration has been carried out at the Meteorological Observatory at Mt. Fuji. Other work is underway on the effects of atmospheric aerosol particles on climate and weather.

The Applied Meteorology Division deals with air pollution and radioactivity, ice and cloud nuclei, and environment meteorology. Another area which appears somewhat out of place is the study of seasonal variation of Japanese mortality, a factor which appears to be influenced by the advances in medicine and pharmacology as well as better housing and food and improvements in artificial temperature control. For those of us who at one time or another have been exposed to inadequately heated and insulated rooms in severe weather (visit some university classroom in late January), this is a vital problem. In this area under study is the profile of infant mortality rates for specific diseases over seasons.

The Seismology and Volcanology Division studies earthquake prediction, prediction of volcanic activity, earthquake mechanism and seismic activity, and the development of seismological instruments. In the research in prediction of volcanic eruptions, four active volcanoes are constantly scrutinized for ground deformations, ground tilt, and temperature changes. Two others are under study for analysis of the fire running phenomena of volcanic eruptions. Another project is investigating the potential for ocean bottom seismographs connected to an on-shore station for continuous monitoring of ocean bottom seismic activity.

In the Oceanographical Division the areas of interest are ocean waves, oceanic conditions, air-sea interactions, oceanographic instruments, and coastal environment. Variations in water temperatures for different locations have been plotted to note sea surface temperatures and measure wind effects. A wave recorder was developed to read the mean wave height and period as well as temporal variations. A method based on the radiative transfer equation containing five energy transfer processes has resulted in an improved numerical model to predict ocean wind waves. Coastal environment is being studied through the accumulation of on-going records of water temperature and salinity, current, air temperature, wind and wave.

The upper Atmosphere Physics Division studies the upper atmosphere, radiation, cosmic rays, and atmospheric electricity. It operates an automatic spectro-pyrheliometer for spectral measurement of direct solar radiation and uses a helicopter mounted with two pyranometers to estimate the absorption of solar radiation by atmospheric aerosols. In the area of cosmic-ray observation, they have studied atmospheric effects on cosmic-ray intensity using an ionization chamber filled with pure argon gas of 30 atmospheres, shielded by 10cm of lead.

In the Geochemical Division the emphasis is on the geochemical study of atmosphere and oceans and the radioactivity in atmosphere and oceans. They have concluded that the data indicate that tritium content of surface water is related to recent fallout from the stratosphere. Also under study are the distribution of free CO_2 in surface water in the Pacific and the vertical diffusion of radioactive materials close to the ocean bottom.

The Meteorological Satellite Division is concerned with satellites, instrumentation, weather radar, and meteorological lidar (laser radar). The mission of this group includes earth observation from a geostationary orbit, data collection from automatic weather stations, dissemination of processed data, and monitoring of solar protons with energies greater than 100 MeV. Lidar is used in the detection of polluted air.

A LOOK AT THE JAPANESE POLAR RESEARCH PROGRAM

Morton A. Bertin

The information in this report came from discussions with members of the staff and was also gleaned from publications of the Institute. At the time of my visit to the National Institute of Polar Research the place was a beehive of activity, with a team of young men in the process of gearing up for a one and a half year tour in the Antarctic. The first Japanese Antarctic Research Expedition, timed to participate in the program of the International Geophysical Year (1957-58), set up the SYOWA Scientific Station on East Ongul Island. On-going research has been carried out in such areas as upper atmosphere physics, meteorology, geodesy, geology, glaciology, seismology, oceanography, biology, and medical sciences. With only a brief hiatus in operation, the station has been continuously used as a polar research site.

The Institute itself first came into being in 1962 and was originally established as the Polar Research Section of the National Science Museum. Probably reacting to an increased awareness of Japan's interest in the Antarctic, in 1973 the Ministry of Education, Science, and Culture set it up as an independent entity in its present form. The Institute has a permanent staff of 82 with eight visiting professors and operates on an annual budget of one and a half million U.S. dollars. A separate budget of slightly over two million dollars pays for the expeditions sent to the Antarctic. Transport as well as some logistic support for the expeditions is provided by the Japanese Self Defense Forces by making available the icebreaker Fuji, which also acts as a floating observation platform for the scientists en route as well as on station. The ship has a displacement of 7,760 tons, can transport 500 tons of cargo, and will handle 240 men, a crew of 200 and 40 expedition members. It carries two Sikorsky and one Bell helicopter. In recent years a team of about 30 men have spent winters at Syowa Station and have investigated areas in Lützow-Holm Bay, Yamato Mountains, and the Sandercock Nunatacks. Those seeking more specific locale information can obtain these by contacting the Institute. Exposed areas in the Prince Olav Coast, Soya Coast, and Prince Harald Coast have been studied by earth scientists, and several melt water pools have been found. Hydrogeochemical and biological studies have been conducted in those found to be saline. Though fauna and flora are sparse, several Adelie penguin rookeries exist on Prince Olav and Soya Coasts.

Rocket launching sites have been developed, consisting of a rocket motor magazine, a radar-telemetry hut, and an assembly shop. During the period of 1970-1973, 23 rockets were launched, with the primary aim of studying plasma particles and electric and magnetic fields associated with auroras. A new class of sounding rockets is under development, scheduled for launching during the period of 1976-1979, in support of the International Magnetospheric Study.

Extensively studied has been the range of Yamato Mountains, some 300 km south of the station. During my visit I was shown what is probably the largest single collection of meteorites, all discovered in this region. The fields listed as under study by the group in this area are geology, geomorphology, meteorology, glaciology, geomagnetism, gravity, and meteorite research. For interested geologists the Yamato Mountains are described as divided into charnockite and granite groups of the Precambrian to early Paleozoic ages.

In addition to Syowa Station, the Expedition in 1970 also established Mizuho Camp, set up on an island ice sheet. Mizuho has been used periodically to study specific problems related to meteorology, glaciology, geomagnetism, and upper atmosphere physics. One of the major achievements of the Expedition was the traverse to the South Pole from Syowa, accomplished in 141 days. The twelve member team covered 5,200 km and recorded the minimum air temperature of 60°C, carrying out periodic studies in seismology, radio echo sounding, glaciology, geomorphology, geodesy, geomagnetism, VLF emission, gravity, and human physiology. Numerous

publications document the results of this expedition and other findings of the Station and there are news bulletins and scientific reports issued periodically.

In addition to the Antarctic Research Expedition, the Institute provides logistic and other support to the Dry Valley Drilling Project and the International Magnetospheric Study. In the former, they cooperate with New Zealand and the United States in conducting a scientific program in Victoria Land, Antarctica. In the latter the Institute is involved in a joint program with France and Iceland in carrying out conjugate point observations in Iceland. They also provide facilities for graduate students working on doctoral research and act as a repository for Antarctic data collected by various expeditions.

DO YOU HEAR THE SINGING OF THE CICADAS?

M. A. Bertin and E. A. Kearsley

The singing of cicadas in the late summer trees of a Tokyo park is ever-present and monotonic to the point that one is soon unaware of it. Yet it is common for Japanese, by way of pleasantry, to remark on the agreeable sound. Indeed, Japanese frequently strike Westerners as having a range of perceptions beyond that of others, seeming to see things, enjoy tastes and savor other sensations outside the ken of "gaijins" (foreigners). We were therefore extremely intrigued by our recent visit to a researcher-physician who asserts that certain sounds are differently perceived by Japanese and non-Japanese.

Tadanobu Tsunoda is on the staff of the Medical Research Institute of the Tokyo Medical and Dental University and for years has studied the influence of cerebral hemispheric dominance on hearing and listening. Working with patients diagnosed as having auditory disorders, Tsunoda developed the Cerebral Dominance Key-Tapping Test as a tool for the evaluation of pathological cerebral conditions. He also noted that the device is useful to determine dominance for a variety of sounds in normals. The apparatus is a two channel auditory feedback recorder activated by an electronic key. A delay switch enables the experimenter to institute a feedback delay to one ear or the other. In the latest method, the subject, equipped with earphones, taps his finger in a certain rhythmic pattern (4, 2, 4, 2, ...) as fast as possible into an optically activated switch. The make and break of the switch is used to record the rhythm of the tapping with a pen recorder and to send to one ear a corresponding interrupted signal from a recorded sound of the experimenter's choice. In this condition, there is no disturbing effect of the feedback on the pattern of the tapping and the subject practices until he can tap without thinking of it. Subsequently, another channel is introduced which delays the signal a few hundredths of a second and sends it to the second ear. The subject is thus subjected to a dichotic competition and a disturbance in the regularity of the tapping occurs. By decreasing the loudness of the delayed signal in successive trials, a threshold for the disturbance can be established. Once this is achieved for one ear, the conditions are reversed so that the delayed signal is fed to the other ear and another threshold is measured. This allows for a comparison and the ratio of left to right ear thresholds, expressed in decibels, is taken as a measure of cerebral hemisphere dominance. (As with many bodily functions, the left ear corresponds to the right hemisphere, etc.)

Using as a sound source (1) a recording of a steady pure /a/ vowel tone, (2) a 1 kHz pure tone and (3) white noise, the method was applied to 92 "normal" Japanese subjects. Tsunoda found that about 72% showed the typical pattern of left hemisphere dominance for the vowel sound (which is usual for speech) and right hemisphere dominance for the pure tone and the white noise (which is usual for machine noise and orchestral music). About 8% of these subjects showed the mirror image of this pattern, but again the vowel sound was dominant in hemispheres opposite from the other sounds. For about 18% of these subjects, no hemisphere dominance could be detected and for the remaining 2%, all three sounds were dominant on the same side. This last pattern has been shown to be typical of aphasics with hemiplegia. Indeed, the original purpose of the test was the localization of the site of brain damage.

Tsunoda then noted that some results in the West (by the Kimura method) did not show any distinctive tendency for the dominance effect of vowels. He therefore tried his new method on a number of Westerners resident in Japan with surprising results—a distinct dominance effect of the steady-state vowel /a/ in the non-verbal hemisphere was found for Western subjects. Tsunoda conjectured that in the Western tests the use of syllables with consonants and other test conditions had associated the sounds with speech in the subjects' minds. Indeed, "loading" the Tsunoda test with speech (by simultaneous reading or listening) or even with nonsense speech-like sounds ("doop, doop" by bone conduction) caused the dominance effect to decrease or disappear.

What the results seem to suggest is that Westerners perceive a steady-state pure vowel sound as a noise (or perhaps music), while to Japanese it is a verbal sound. Tests with foreign born Japanese (who had been brought up with the local language) were comparable to those of Westerners as were those of Chinese and Korean subjects, so that the effect is apparently neither genetic nor Oriental in essence.

Tsunoda then went on to test a variety of other sound sources – (1) verbal sounds (vowels, consonants, synthesized vowels), (2) emotive sounds (humming, laughter, cries, sighs, snores), (3) animal sounds (those of the cricket, "bell-ring" insect, cicada, frog, sparrow, bird, dog, cat, cow, chicken, lion) and (4) mechanical sounds (1 kHz pure tone, white noise, FM sound, violin A sound, A sound played by an orchestra, temple bell, church bell, whistle, sound of helicopter, etc.). The puzzling difference also emerged in dominance for emotive and animal sounds, the native Japanese "hearing" them in the left or verbal hemisphere whereas the others "heard" them in the right half of the brain. Even stranger, the Japanese "hear" traditional Japanese instruments on the verbal side and western music on the other. Westerners "hear" all music on the same side.

Tsunoda asserts that these differences between the two groups of subjects are attributable to a "difference in the perception mechanism of complex sounds." He concludes that there is a special switching mechanism operating in vowels which for the Japanese often have meanings beyond the simple letter association. That is, the vowels themselves are language connotative and frequently a single vowel will have complete and diverse meanings. On the other hand, for the westerner the vowel is a mere fraction of a thought pattern, the basic units of language being syllables.

The findings are provocative and open the door to theories about the unique characteristics of Japanese thought and culture. That the phenomenon is not simply Asiatic or Oriental has been shown by the tests administered to Indians, Koreans, and Chinese. It will be of considerable interest to follow what emerges if people with languages which have some remote similarity to Japanese (Finns, Hungarians, Polynesians) are tested.

There is an old trite saying to the effect that to learn to speak Japanese well you must begin by being born in Japan of Japanese parents. Can it be that there is more behind this maxim than the intricate grammar of levels of etiquette in the language?

According to Tsunoda the differences in hemispheric dominance for certain sounds are more than a simple environmental overlay on the auditory mechanism. He conjectures rather that they reflect important emotional and mental differences, that is differences in thought and feeling patterns. Does the fact that the Japanese love the song of the cricket while the westerners do not even seem to hear it imply basic and deeply rooted cultural schisms? Tsunoda cites work by Mayako Ikeda which showed that Americans are not aware of the "singing of insects," and taking off from this, Tsunoda abandons the laboratory to delve into more hypothetical aspects of human behavior.

He perceives the normal sensory mechanisms of the Japanese brain as being consistent with "the vague naturalness, emotion, logic, and ethics as seen in the Japanese people and culture," and he cites as support the various uniquely Japanese art forms of flower arrangement, tea ceremony, Noh dances, and so on. The Japanese are more concerned with things such as duty and sentiment than with ethics. Westerners, on the other hand, have a perception mechanism which emphasizes ethics and logic instead of feeling.

From here Tsunoda rationalized relationships of one or the other of the groups to such things as Zen, Cartesian dualism, science and engineering, individualism, and religion. His primary point seems to be that in order to increase communication and improve understanding between Japanese and the west; it is vital for each to understand that the differences of the sound perception mechanisms are strongly operating forces which impose strikingly unique characteristics on each. He offers no value judgments, implying that each has the potential for making a contribution to the other. In turn, we likewise offer no value judgment and simply say that after many intriguing and stimulating months in contact with the Japanese culture, puzzling over countless things that we can't truly fathom or explain, Tsunoda's theories provide a provocative if somewhat inflexible rationale for feeling that "east is east, and west is west, and never the twain . . ."